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ABSTRACT

Designed for use with individualized instructional units (CE 026 345-347, CE 026 349-351) in the REACH (Refrigeration, Electro-Mechanical, Air-Conditioning, Heating) electromechanical cluster, this second volume of the postsecondary teacher guide contains the check points which the instructor may want to refer to when the unit sheet directs the student to receive an instructor check. Each check point sheet also contains a general comments section designed to suggest to the instructor different media, tools, and equipment which may be necessary to accomplish the objective. (LRA)

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# REACH

TEACHER'S GUIDE VOLUME II

CHECK POINTS

DEVELOPED UNDER CONTRACTUAL AGREEMENT

WITH

DIVISION OF PROGRAM DEVELOPMENT
OFFICE OF VOCATIONAL EDUCATION
GEORGIA DEPARTMENT OF EDUCATION
ATLANTA, GEORGIA 30334
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BY

VOCATIONAL EDUCATION TEACHERS

AND

THE UNIVERSITY OF GEORGIA STAFF

UNDER THE DIRECTION

OF

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DIVISION OF VOCATIONAL EDUCATION
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JUNE, 1980

U.S. DEPARTMENT OF HEALTH,
EDUCATION & WELFARE
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# TEACHER'S GUIDE VOLUME II
## CHECKPOINTS

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# INTRODUCTION

This volume of the Teacher's Guide contains the check points which the instructor may want to refer to when the unit sheet directs the student to recieve an instructor check.

The check point sheet also contains a General Comments section designed to suggest to the instructor different media, tools, and equipment which may be necessary to accomplish the objective. This section should be kept up to date through-out the course. This will help to provide the information needed to tailor each learning package to fit the restraints placed upon the program by limited funds, equipment, tools, etc.

The Authors

## AIR CONDITIONING

1. Air conditioning Fundamentals

AC-01 Demonstrate a knowledge of air conditioning systems

AC-02 Applying basic air principles

AC-03 Calculating heat loads

AC-04 Applying principles of air movement

AC-05 Identifying air filtering systems

II. Window Air Conditioning

AC-06 Installation of a window unit

AC-07 Performing pre-season start up for window A/C

AC-08 Troubleshooting compressor burnout in a window A/C

AC-09 Evacuating and charging a window A/C unit

AC-10 Troubleshooting fans and fan motors

AC-11 Troubleshooting window air conditioner's (refrigeration cycle)

AC-12 Troubleshooting window air conditioner electric system

III. System and Installation

AC-13 Install condensate drain

AC-14 Installing package unit (residential and mobile home)

AC-15 Installing split system

AC-16 Installing add-on split system

AIR CONDITIONING (continued)

IV. Troubleshooting and servicing

- AC-17 Troubleshooting compressor burnout
- AC-18 Troubleshooting fans and fan motors
- AC-19 Performing pre-season start up
- AC-20 Troubleshooting air conditioner's (refrigeration cycle)
- AC-21 Troubleshooting air conditioner's (electrical cycle)
- AC-22 Troubleshooting air conditioner's (air movement)

V. Heat Pump

- AC-23 Understanding principles of the heat pump
- AC-24 Evacuating and charging the heat pump
- AC-25 Installing reversing valve (refrigeration cycle)
- AC-26 Refrigeration cycle and components
- AC-27 Installing electrical circuits
- AC-28 Adjusting and repairing defrost controls
- AC-29 Designing supplementary heat systems
- AC-30 Installing package heat pump
- AC-31 Installing split system
- AC-32 Troubleshooting heat pump

## ELECTRICITY

1. Fundamentals

    EL-01. Understanding basic electrical theory

    EL-02. Computing Ohm's law and power formulas

    EL-03. Using electric meters

    EL-04. Identifying series and parallel circuits

    EL-05. Identifying electrical symbols

    EL-06. Reading a basic schematic diagram

    EL-07. Reading an advanced schematic diagram

    EL-08. Understanding alternating current principles

    EL-09. Determining, selecting wire size and making connections

    EL-10. Making main panel connections - air conditioners

II. Electric Motors

    EL-11. Servicing shaded pole motors

    EL-12. Wiring split phase motors

    EL-13. Checking capacitors

    EL-14. Hooking up and troubleshooting a PSC (capacitor run) motor

    EL-15. Hooking up and troubleshooting a CS motor

    EL-16. Hooking up and troubleshooting a CSR motor

    EL-17. Hooking up a three phase motor

    EL-18. Testing motors

    EL-19. Maintenance of electric motors

ELECTRICITY (continued)

III. Electrical Components

EL-20. Installing and testing a transformer

EL-21. Installing and testing contacts and relays

EL-22. Installing and checking thermostats

EL-23. Installing and checking pressure switches

EL-24. Troubleshooting an overload

EL-25. Installing and checking miscellaneous controls

EL-26. Troubleshooting magnetic starters

IV. Controls and Installation

EL-27. Wiring packaged air conditioners

EL-28. Wiring split system air conditioner

EL-29. Designing control panel

EL-30. Designing advanced control panel

EL-31. Troubleshooting electrical control system (basic)

EL-32. Troubleshooting electrical control system (advanced)

EL-33. Servicing solid-state control circuits

## REFRIGERATION

1. Refrigeration Fundamentals

    REF-01 Identifying career opportunities in Refrigeration, Heating and Air Conditioning

    REF-02 Identifying safe working conditions

    REF-03 Understanding basic refrigeration concepts

    REF-04 Understanding the basic refrigeration cycle

    REF-05 Identifying tools

    REF-06 Tapping, threading, and replacing threads

    REF-07 Fitting nonenclosure and pipe materials

II. Tubing and Pipe

    REF-08 Basic copper tubing operations

    REF-09 Soft soldering copper tubing

    REF-10 Silver brazing

III. Refrigerants

    REF-11 Handling refrigerants

    REF-12 Using access valves

    REF-13 Maintaining refrigeration manifold gauges

    REF-14 Installing and using refrigeration manifold gauges

    REF-15 Using a vacuum pump

    REF-16 Installing refrigeration accessories

    REF-17 Testing for leaks

    REF-18 Charging the system

## REFRIGERATION (continued)

### IV. Troubleshooting

REF-19 Testing the compressor
REF-20 Applying principles of condenser
REF-21 Applying principles and uses of the evaporator
REF-22 Troubleshooting an automatic expansion valve
REF-23 Applying principles of troubleshooting capillary tubes
REF-24 Troubleshooting thermostatic expansion valve
REF-25 Troubleshooting the refrigeration system

### V. Window Air Conditioning

REF-26 Installation of a window unit
REF-27 Performing pre-season start up or window A/C
REF-28 Troubleshooting compressor burnout in a window A/C
REF-29 Evacuating and charging a window A/C unit
REF-30 Troubleshooting fans and fan motors
REF-31 Troubleshooting window air conditioner's (refrigeration cycle)
REF-32 Troubleshooting window air conditioner electric system

### VI. Refrigerators and Freezers

REF-33 Understanding basic operations of a refrigerator or freezer
REF-34 Evacuating and charging refrigerators and freezers
REF-35 Troubleshooting refrigerators and freezers (refrigeration cycle)
REF-36 Troubleshooting fans and fan motors
REF-37 Troubleshooting compressor burnout on refrigerators and freezers
REF-38 Troubleshooting refrigerators and freezers (electrical cycle)

## RESIDENTIAL WIRING

1. Grounded Outlets

REW-01 Installing 115v appliances outlets

REW-02 Installing convenience outlets

REW-03 Installing lighting outlet

REW-04 Installing split and switched receptacles

REW-05 Installing a doorbell circuit

REW-06 Installing a three-way switch

REW-07 Installing a 230v circuits and outlets

II. Service Entrance

REW-08 Installing service entrance

REW-09 Install main panel

REW-10 Installing temporary service

III. Blueprint Reading

REW-11 Using standard measurement

REW-12 Identifying residential wiring symbols and designing circuits

REW-13 Estimating materials

## MAJOR APPLIANCE

1. Installation of Appliances

| | |
|---|---|
| MA-01 | Installing electric ranges |
| MA-02 | Installing electric oven |
| MA-03 | Installing surface unit and hood |
| MA-04 | Installing automatic electric dryers |
| MA-05 | Installing washing machine |
| MA-06 | Installing dishwasher |
| MA-07 | Installing garbage disposals |
| MA-08 | Installing refrigerator and freezer |
| MA-09 | Transporting major appliances |

II. Troubleshooting Washing Machine

| | |
|---|---|
| MA-10 | Total washing machine operation |
| MA-11 | Electrical systems operation and troubleshooting |
| MA-12 | Testing and installing capacitors |
| MA-13 | Mechanical systems operation and troubleshooting |
| MA-14 | Checking and replacing belts |
| MA-15 | Water systems operation and troubleshooting |
| MA-16 | Servicing dryer mechanical and air systems |
| MA-17 | Servicing dryer electrical systems |

MAJOR APPLIANCE (continued)

III. Troubleshooting automatic dishwasher

- MA-18 Testing and replacing solenoid
- MA-19 Checking water level control and testing and replacing safety door switch
- MA-20 Checking and replacing heating element on dishwasher
- MA-21 Testing and replacing motor relay
- MA-22 Replacing automatic dispenser
- MA-23 Testing and replacing drain pump
- MA-24 Testing and installing timer
- MA-25 Diagnosing and repairing automatic dishwasher

IV. Troubleshooting electric range

- MA-26 Testing and replacing surface unit elements
- MA-27 Testing and replacing surface unit switches
- MA-28 Testing and replacing oven elements
- MA-29 Testing and replacing oven temperature controls
- MA-30 Replacing automatic timers
- MA-31 Service continuous cleaning and self-cleaning ovens

## HEATING

I. Electric Heating Systems

HE-01 Demonstrate a knowledge of the principles of electric furnaces and controls

HE-02 Installing electric furnaces

HE-03 Troubleshooting electric furnaces

II. Gas Heating Systems

HE-04 Applying gas fuel combustion and safety principles

HE-05 Understanding basic systems (types of furnaces)

HE-06 Checking gas sources

HE-07 Gas piping principles

HE-08 Adjusting regulators

HE-09 Installing and servicing gas valves

HE-10 Installing and servicing pilot ignition devices

HE-11 Installing and servicing combination gas valves

HE-12 Servicing burners

HE-13 Inspecting and determining temperature rise of heat exchangers

HE-14 Venting heat system

HE-15 Servicing electrical controls

HE-16 Determining combustion efficiency

HE-17 Performing pre-season checkup and start up

HE-18 Troubleshooting the heating system

HEATING (continued)

III. Oil Burning Systems

HE-19 Identifying types of fuel oil and principles of combustion

HE-20 Designing and installing oil piping

HE-21 Installing oil burners

HE-22 Installing and servicing transformers and electrodes

HE-23 Installing oil pumps

HE-24 Servicing blower, nozzle, motor and coupling

HE-25 Recognizing types of heat exchangers and performing the combustion test

HE-26 Installing controls

HE-27 Performing pre-season start up and checkup

HE-28 Troubleshooting the oil burning heating system

HE-29 Installing and servicing humidifiers

# MAJOR BLOCK

## AIR CONDITIONING

| | | | |
|---|---|---|---|
| AC-06 | -- | AC-12 | Secondary |
| REF-26 | -- | REF-32 | |
| AC-01 | -- | AC-32 | Post Secondary |

UNIT NO. AC-01

OBJECTIVE:

Demonstrate a knowledge of human comfort control and identify the methods of air conditioning.

GENERAL COMMENTS:

Instructor to give assistance in locating the different types of air conditioning systems from the lab area. If all systems are not available, the instructor may describe the systems from a manufacturers spec sheet, or from a text book.

CHECK POINTS:

C-1 Instructor to check all answers on the assignment sheet which applys to equipment nomenclature, manufacturers, capacity, etc.

C-2 (1) Instructor to ask oral questions from the text assignment.
(2) Instructor to ask oral questions from the information sheet.

UNIT NO. AC-02

OBJECTIVE:

Determine air properties through the use of graphs and psychrometics.

GENERAL COMMENTS:

The instructor should assist the student with terminology of the psychrometics. Further, the instructor may familiarize the student with the psychrometic chart.

CHECK POINTS:

C-1 Instructor should ask oral questions from text assignment and information sheets.

C-2 Instructor should ask oral questions from the assignment sheet and check job sheet.

C-3 Instructor to ask oral questions from the slide/set, check the job sheet and evaluate the total unit.

UNIT NO. AC-03

**OBJECTIVE:**

Calculate Heat Loads

**GENERAL COMMENTS:**

**CHECK POINTS:**

C-1 The answers are:

1. f
2. d
3. g
4. n
5. a
6. b
7. c
8. e

C-2 In charts 1 and 2, the students should list at least 5 heat loss and gain factors such as walls, floor, ceiling, windows, door, ventilation, etc. Ask them about any they omit.

C-3 See below

C-4 See below

NOTE: No two people do a heat study exactly the same. Therefore, the student's figures may be somewhat different than these but still be correct. Attached however is a sample of what the completed form should look like.

| LR 5. | | | BR #3 4. | | | BR#2 3. | | | BATH 2. | | | Master BR 1. | | | Entire House | | | | | | | Name of Room | 1. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19 | | | 13 | | | 24 | | | 8 | | | 4[illegible] | | | | | | | | | | Room Dimensions, Feet | 2. |
| 19 x 17 | | | (13x10)(5x2) 15ft² | | | (14 x 10)(2x5)+15ft² | | | 10 x 7 | | | (14x14)(5x9)+15ft² | | | | | | | | | | Exposed Wall Expressed in Running Feet | 3. |
| 8 | | N | 8 | | N | 8 | | NW | 8 | | W | 8 | | SW | | | | | | | | Ceiling HT, FT Directions Room Faces | 4. |
| Btuh | | Area or Length | Btuh | | Area or Length | Btuh | | Area or Length | Btuh | | Area or Length | Btuh | | Area or Length | Btuh | | Area or Length | HTM | | No. | Const. | TYPE OF EXPOSURE | |
| Clg | Htg | | Clg | Htg | | Clg | Htg | | Clg | Htg | | Clg | Htg | | Clg | Htg | | Clg | Htg | | | | |
| | | 152 | | | 104 | | | 192 | | | 64 | | | 344 | | | | | | | a. | Total Exposed Partitions and Walls | 5. |
| | | | | | | | | | | | | | | | | | | | | | b. | | |
| | | | | | | | | | | | | | | | | | | | | | c. | | |
| | | | | | | | | | | | | | | | | | | | | | d. | | |
| | .5 | 10 | | 1 | 20 | | 113 | 26 | | .25 | 5 | | 1.35 | 27 | | | | | 50 | 2c | a. | Windows and Sliding Glass Doors (heating) | 6. |
| | | | | | | | | | | | | | | | | | | | | | b. | | |
| | | | | | | | | | | | | | | | | | | | | | c. | | |
| | | 10 | | | 20 | .33 | | 13 | | | | | | | | | | 25 | North | | | Windows and Sliding Glass Doors (heating) | 7. |
| | | | | | | .98 | | 13 | .38 | | 5 | .38 | | 5 | | | | 75 | NE & NW or E & W | | | | |
| | | | | | | | | | | | | .88 | | 22 | | | | 40 | SE & SW or South | | | | |
| .52 | 5.4 | 40 | | | | | | | | | | | | | | | | 75/13 | 135/13 | 124 | 55 | Other Doors | 8. |
| .28 | .29 | 102 | .22 | .24 | 84 | .45 | .47 | 166 | .16 | .2 | 61 | .86 | .89 | 317 | | | | 10f | 2.8 | 2.7 | a. | Total, Net Exposed Partitions and Walls | 9. |
| | | | | | | | | | | | | | | | | | | | | | b. | | |
| | | | | | | | | | | | | | | | | | | | | | c. | | |
| | | | | | | | | | | | | | | | | | | GAR | 2.8 | 1 | d. | | |
| .29 | .39 | 323 | .14 | .19 | 155 | .15 | .2 | 165 | .06 | .08 | 70 | .28 | .37 | 306 | | | | 14j | 1.2 | .9 | a. | Ceilings Area | 10. |
| | | | | | | | | | | | | | | | | | | | | | b. | | |
| .32 | 1.26 | 323 | .16 | .6 | 155 | .17 | .64 | 165 | .07 | .27 | 70 | .3 | 1.2 | 306 | | | | 17d | 3.9 | 1 | a. | Floor Areas | 11. |
| | | | | | | | | | | | | | | | | | | 20b | 40 | — | b. | | |
| | | | | | | | | | | | | | | | | | | | | | | Ventilation | 12. |
| | 7.84 | | | 2.09 | | | 2.61 | | | .8 | | | 3.81 | | | 33000 | | | | | | Sub Total Heat Loss (Btuh) | 13. |
| | | | | | | | | | | | | | | | | | | | | | | Duct Heat Loss (Btuh) | 14. |
| | | | | | | | | | | | | | | | | | | | | | | Total Heat Loss (Btuh) | 15. |
| | | | | | | | | | | | | | | | | | | | | | | Btuh Heat Loss @ 300 Per Person | 16. |
| .9 | | 3 | | | | | | | | | | | | | | | | | | | | Total 1200 Btuh for Appliances | 16.a |
| 2.56 | | | 102 | | | 2.08 | | | .67 | | | 243 | | | | | 15000 | | | | | Total Sensible Heat Gain (Btuh) | 17. |
| | | | | | | | | | | | | | | | | | | | | | | Total Duct Gain Btuh | 18. |
| | | | | | | | | | | | | | | | | | | | | | | Total of Lines 17 and 18 (Cooling) | 19. |
| | | | | | | | | | | | | | | | | | | | | | | Heat Gain (line 19 x 1.3) | 20. |
| | | | | | | | | | | | | | | | | | | | | | | Btuh for Air Quantities | 21. |

| Utility | | | GARAGE | | | DINING | | | Kitchen | | | FOYER | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6 | | | 52 | | | 10 | | | 9 | | | 3 | | |
| 6 x 6 | | | (30x14) - (6x6) | | | 12 x 10 | | | 9x8 | | | 5x12 | | |
| 8 | | N | 10 | | N-E-S | 8 | | S | 8 | | S | 8 | | S |
| Btuh | | Area or Length | Btuh | | Area or Length | Btuh | | Area or Length | Btuh | | Area or Length | Btuh | | Area or Length |
| Clg | Htg | | Clg | Htg | | Clg | Htg | | Clg | Htg | | Clg | Htg | |
| | | 48 | | | 520 | | | 80 | | | 72 | | | 44 |
| | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| | .25 | 5 | | .65 | 13 | | 1.1 | 22 | | .5 | 10 | | | — |
| | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| .13 | | 5 | | | | | | | | | | | | — |
| | | | .98 | | 13 | | | | | | | | | |
| | | | | | | .88 | | 22 | .4 | | 10 | | | |
| | | | .26 | 1.5 | 20 | | | | | | | .11 | 2.48 | 20 |
| .12 | .12 | 43 | .69 | .7 | 255 | .16 | .16 | 58 | .14 | .15 | 62 | .06 | .07 | 24 |
| | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| | | | | .7 | 232 | | | | | | | | | |
| .03 | .04 | 36 | .35 | .5 | 386 | .1 | .14 | 120 | .06 | .08 | 72 | .05 | .07 | 60 |
| | | | | | | | | | | | | | | |
| .03 | .14 | 36 | | | | .12 | .47 | 120 | .07 | .28 | 72 | .06 | .2 | 60 |
| | | | - | 3.4 | 86 | | | | | | | | | |
| | | | | | | | | | | | | | | |
| | .55 | | | 7.5 | | | 1.87 | | | 1.00 | | | 2.82 | |
| | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| | | | | | | .6 | | 2 | 1.2 | | 1 | | | |
| .31 | | | 2.28 | | | 1.86 | | | 1.47 | | | | | |
| | | | | | | | | | | | | .28 | | |
| | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |

UNIT NO. AC-04

**OBJECTIVE:**

Apply principles of air movement through ductwork and air distribution inside the room.

**GENERAL COMMENTS:**

Learn to use air measurement instrument.

**CHECK POINTS:**

C-1 Make sure the student is reading only static pressure. Does the student understand that the reading is a combination of the water going down in one side and up in the other?

C-2 Make sure the student got an average reading of the total area. See that the student understands what happens to the air flow with stop up filters.

C-3 Using the anemometer, make sure the student got an average feet per minute.

UNIT NO. AC-05

**OBJECTIVE:**

Identify and install air filters.

**GENERAL COMMENTS:**

**CHECK POINTS:**

C-1 Make sure the student doesn't bump or loosen dirt from the filter until it is in an unfiltered location. Observe filter coating making sure it is applied evenly.

C-2 Make sure the student understands what voltage to expect and that it is very low amperage. Therefore, electrical connections within the unit must be very good.

For AC-06 through AC-12 refer to the table below:

| Checkpoint Number | Corresponds With |
|---|---|
| AC-06 | REF-26 |
| AC-07 | REF-27 |
| AC-08 | REF-28 |
| AC-09 | REF-29 |
| AC-10 | REF-30 |
| AC-11 | REF-31 |
| AC-12 | REF-32 |

UNIT NO. AC-13

OBJECTIVE:

Identify and install condensate drain.

GENERAL COMMENTS:

Enough plastic pipe and fittings to do job must be available.

CHECK POINTS:

C-1 Check drawing for correct materials, slope and trap depth.

C-2 Check the following points:

  (a) Grade slope of the ¼ inch per foot

  (b) A 3-inch trap below the drain pump

  (c) Correct amount of glue used

  (d) Hook drain line up to pressure and see if it leaks

C-3 Check drawing for accuracy

C-4 Check the following points

  (a) Drain line near vent is metal

  (b) Proper trap has been installed

  (c) Enough flexibility in line to remove the filter

C-5 Check the following points:

  (a) Horizontal pipe slants away from unit

  (b) Pump is level

  (c) Pump is below the coil drain and float works freely

UNIT NO. AC-14

OBJECTIVE:

To install a package cooling system for residential or mobile home.

GENERAL COMMENTS:

It will be necessary to have a package cooling system available for installation in residential or a mobile home mock up.

CHECK POINTS:

C-1 Observe student during installation and check work when finished (proper clearance, etc.).

C-2 Same as above except for mobile home installation.

UNIT NO. AC-15

BJECTIVE: Install and wire a split system cooling unit.

GENERAL COMMENTS:

CHECK POINTS:

C-1
- a. Level
- b. Clearance for service
- c. Clearance for air circulation
- d. Noise will be unobjectionable.
- e. Close to inside unit as possible
- f. Slab is sufficiently larger than unit
- g. Provision made to keep slab from sweating and rusting out bottom of unit
- h. Electrical weather-proof disconnect
- i. Wiring in weather-proof conduit
- j. Pipeing does not come in contact with foundation

C-2
- a. What type unit to use
- b. Where should the unit be located in relation to the conditioned space and outside unit.
- c. How many different (basic) positions can a blower position.

C-3
1. Neatness
2. For kinks
3. How tubing is hung
4. Does it touch the foundation
5. Leak test and evacuation

C-4
1. Is wiring correct size
2. Is disconnect and conduit weather proof
3. Is wiring to correct terminals
4. Pre-charge tubing has the following advantage
    - a. Easy to kink
    - b. Already open ready to be installed
    - c. Always the correct length
    - d. None of the above
5. What designates the wire size use to a unit
    - a. General contractor
    - b. Electrical wholesaler
    - c. Unit name plate and distance d. The wire you have available

UNIT NO. AC-16

OBJECTIVE:

Install a Ground Level Condenser

GENERAL COMMENTS:

Job Sheets AC-16a, b, and c are a series of related tasks. AC-16c is the culminating activity which connects AC-16a and AC-16b Job Sheet products.

CHECK POINTS:

C-1 The instructor should check the installation of the outside condenser-compressor unit for the following:

a. level
b. clearance for service
c. clearance for air circulation
d. noise will be unobjectionable
e. close to inside unit as possible
f. slab is sufficiently larger than unit
g. provision made to keep slab from sweating
h. electrical weatherproof disconnect
i. wiring in weatherproof conduit
j. piping does not come in contact with foundation

C-2 The instructor should check the coil's location in relation to the heat exchanger. NOTE: The student's next activity will be to connect the outside unit and the indoor coils with appropriate piping.

C-3 The instructor should check the installation for:

a. neatness
b. for kinks
c. how tubing is hung
d. does it touch the foundation?
e. leak test and evacuation

NOTE: The student's next activity will be to wire the unit using manufacturer's instructions and wiring diagram.

CHECK POINTS (Continued)

C-4 The instructor should check the installation for:

a. correct wiring size
b. disconnect and conduit weatherproof
c. wiring to correct terminals

C-5 The instructor should check the student's entire operation for neatness, safety precautions, and proper operation of the system.

UNIT NO. AC-17

OBJECTIVE:

Troubleshoot and change a compressor burnout

GENERAL COMMENTS:

A disfunctional air conditioning condensing unit may be used to allow the removal and replacement of the burned out compressor. Have the student to evacuate, leak test and recharge a functional unit.

CHECK POINTS:

C-1 Instructor to ask questions related to "Procedures for Determining Compressor Burnout." Make sure the student learns the knowledge of testing the compressor electrically and mechanically.

C-2 Students should have a good feel for clean out procedures. A few key questions issued orally might determine the students' knowledge of clean out procedure.

C-3 Instructor to assign the student to a condensing unit for a compressor removal. Check student progress and workmanship at letter "E" as designated on Job Sheet. Evaluate the student at letter "I" as designated on Job Sheet.

UNIT NO. AC-18

OBJECTIVE:

Troubleshooting, repairing or replacing a fan and a fan motor.

GENERAL COMMENTS:

The instructor will assign the student to a given system in the lab area.

CHECK POINTS:

C-1 The instructor will determine if the student understands motor theory, parts, and wiring diagrams. Have the student use the information sheet throughout the package.

C-2 Instructor will evaluate student performance, ability and workmanship from job sheet. (Evaporator fan motor)

C-3 Instructor will evaluate student performance, ability and workmanship from job sheet. (Condensor fan motor)

UNIT NO. AC-19

OBJECTIVE:

Perform pre-season start up

GENERAL COMMENTS:

The instructor may assign the student a functional air conditioning system from the lab area to perform a pre-season start up. Make sure the student recognizes the check points for the instructor's assistance.

CHECK POINTS:

C-1 Instructor to ask oral questions covering information sheet, text assignment and assignment.

C-2 Instructor to check the work done from the Job Sheet. Make sure the student possesses the knowledge and ability acquired from the Job Sheet. Total evaluation from student's performance from theory, lab and written exercises.

Instructor should stress safety in handling refrigerants.

UNIT NO. AC-20

OBJECTIVE:

Troubleshooting air conditioner refrigeration cycle.

GENERAL COMMENTS:

The instructor should require that students use functional air conditioning systems in lab area to satisfy the job tasks in this unit.

CHECK POINTS:

C-1 The instructor may ask various questions to the student on how to "determine proper charge" ina system.

C-2 The instructor may question the student on how to detect a low and high charge of refrigerant in the system, also, make sure the student has a knowledge of troubleshooting.

C-3 The instructor to bug functional system. Efficient work procedures should be accomplished by the student.

UNIT NO. AC-21

OBJECTIVE:

Troubleshooting air conditioners (electrical cycle)

GENERAL COMMENTS:

Instructor to use functional air conditioning systems for student job sheets.

CHECK POINTS:

C-1 The instructor may ask several questions to the student concerning incoming voltage.

C-2 The instructor to test student's knowledge concerning system components by asking questions.

C-3 (A). Review "Troubleshooting by Symptoms" chart with the student.

(B). Instructor to "fog" several air conditioning systems for the student. The number of systems is to the option of the instructor.

(C). Instructor's grade and evaluation.

UNIT NO. AC-22

OBJECTIVE:

Troubleshoot and service the condenser and evaporator coils (air movement).

GENERAL COMMENTS:

The instructor will use functional air conditioning systems for student troubleshooting. The number of problems assigned to the student is to be specified by the instructor.

CHECK POINTS:

C-1 The instructor should question the student on different types of condenser and evaporator coils and applications they are best used.

C-2 The instructor to check the symptoms listed by the student on the assignment sheet. Might include answer key.

C-3 The instructor will check and evaluate the Job Sheet AC-22a.

C-4 The instructor will check and evaluate the Job Sheet AC-22b.

# MAJOR BLOCK

## ELECTRICITY

| | | | |
|---|---|---|---|
| EL 1 | -- | EL 19 | Secondary |
| EL 1 | -- | EL 33 | Post Secondary |

UNIT NO. EL-01

OBJECTIVE:

You will be able to answer correctly three out of four written questions on electrical fundamentals.

GENERAL COMMENTS:

Instructor should make certain in C-6 that student understands the basic electrical fundamentals.

CHECK POINTS:

C-1 Answers to Assignment Sheet EL-01a

1. There is no definite voltage that can cause injury or death - it depends upon body characteristics.

2. Faulty wiring, improper wiring in homes and carelessness in the industry.

3. An electrical shock causes the heart to flutter instead of beat, causing the heart to stop pumping blood.

4. Make certain the victim is not touching the power source.

5. (1) Check all wiring.
   (2) Use caution when working close to electrical power.
   (3) If possible disconnect power before servicing.
   (4) Inspect wiring.
   (5) Make no quick snap movements if accidentally shocked.

NOTE: Make sure of students knowledge of electrical safety.

C-2 Anwers to Assignment Sheet EL-01b

1. Matter is the substance of which all physical objects is composed.

2. There are 105 elements. The basic component of all matter.

3. (A) Nucleus - control part of atom.
   (B) Proton - heavy positively charges particle containted in the nucleus.
   (C) Neutron - a neutral particle that tends to hold the protons in the nucleus.
   (D) Electron - electrically charged particle that orbits around nucleus.

C-2 continued

4. Monochlordifuoromethane CCIF

    1 - chlorine

    2 - fluorine

    3 - carbon

5. Like charges attract; unlike charges repel.

C-3 Answers to Assignment Sheet EL-01c

1. (A) Static electricity - silk cloth, rubber pad

    (B) Chemical - battery

    (C) Magnetic - generator

2. By cutting the line of a magnetic field.

3. A conductor can transmit electricity.

4. (A) copper

    (B) aluminum

    (C) silver

5. An element that retards electron flow.

    (A) glass

    (B) rubber

    (C) asbestos

6. A conductor gives up free electrons easily while an insulator does not.

C-4 Answers to Assignment Sheet EL-01d

1. A path for electrons to flow with the necessary switches and cords.

2. Electrical pressure is electron flow - volts.

3. (A) Volt - the amount of pressure required to force 1 ampere through a resistance of 1 ohm.

    (B) Ampere - the amount of current required to flow through 1 ohm with a pressure of 1 volt.

    (C) Ohm - one ohm is the amount of resistance that will allow one ampere to flow with a pressure of 1 volt.

C-4 continued

4. (A) Volts - pressure of water

   (B) Amperes - amount of water

   (C) Ohms - resistance of flow of water

5. (A) More resistance - less flow

   (B) Less pressure - less flow

   (C) More flow - high pressure - low resistance

6. (A) Drop in current

   (B) Drop in current

   (C) Drop in voltage or ampere

7. (A) Volt

   (B) Ampere

   (C) Ohm

C-5 Answers to Assignment Sheet EL-01e

1. Electrons actually cause the flow of electricity.

2. (A) Static electricity

   (B) Chemical

   (C) Magnetic

3. A storage battery can be recharged; a dry cell cannot.

4. (A) The volt is the amount of pressure required to force one ampere through a resistance of one ohm.

   (B) An ampere is the amount of current required to flow through a resistance of one ohm.

   (C) One ohm is the amount of resistance that will allow one ampere to flow with a pressure of one volt.

   (D) One thousandth of.

   (E) One thousand of

   (F) An element or substance that will conduct electricity

   (G) An element or substance that will retard the flow of electrons.

   (H) The negatively charged particle of an atom.

UNIT NO. EL-02

OBJECTIVE:

You will be able to answer correctly 9 out of 12 questions and problems on Ohm's Law and Power Calculations on a written test.

GENERAL COMMENTS:

If instructor suspects student has short comings from Unit #1; he should check with student after A-1, which is review.

CHECK POINTS:

C-1
1. 19 ohms
2. 15A, 26A, 29A
3. 336 volts
4. .62A, .21A
5. 77 ohms
6. 20.8A

C-2
1. 4800 watts
2. 1152 watts
3. 11.96 KW
4. 27A
5. 51,150 Btu/hr.

C-3 Check the student's data and claculations on the selected equipment.

C-4 (A)
1. F
2. F
3. T
4. F
5. T
6. F
7. F
8. F

(B)
1. 52.17A
2. 153Ω
3. 300V
4. 108.7A

UNIT NO. EL-03

**OBJECTIVE:**

You will read the voltage, amperage, and ohms of 20 different points in the shop.

**GENERAL COMMENTS:**

1. The instructor should observe the student reading the first section of each job sheet.
2. If necessary, instructor can suggest certain students read operation manual of meter.
3. The points to be checked in the job sheets will have to be selected by instructor for each school.

**CHECK POINTS:**

C-1 Check scale readings of students.

C-2 Check meter readings of students.

C-3 Check scale readings of students.

C-4 Check meter readings of students.

C-5 Check scale readings of students.

C-6 Check meter readings of students.

C-7 Check meter readings of students.

UNIT NO. EL-04

OBJECTIVE:

Demonstrate a knowledge of and identify series, parallel and series/parallel circuits.

GENERAL COMMENTS:

Wiring board should be made available with sockets, switches and other necessary components for the following types of circuitry:

1. Series
2. Parallel
3. Series-Parallel

CHECK POINTS:

C-1 Check Assignment Sheet EL-04a

C-2 (A) Check Job Sheet EL-04a. Students should wire at least two circuits in a series.

(B) Check the student's electrical readings and calculations on circuitry in Figure C.

C-3 Check Assignment Sheet EL-04b

1.
2.
3.
4.
5.
6.
7.
8.

C-4 Check Job Sheet El-04b. Check the students layout and circuitry of a parallel circuit. Make sure also that measurements of the electrical components are correct.

C-5 Check student's drawing of a series-parallel circuit in Assignment Sheet EL-04c.

C-6 (1) Check wiring board #3 which consists of three switches controlling three lights on Job Sheet EL-04c.

(2) Check wiring baord #4, check for layout and circuitry.

UNIT NO. EL-05

**OBJECTIVE:**

Recognize and identify electrical symbols used in refrigeration and heating.

**GENERAL COMMENTS:**

CHECK POINTS:

C-1 Check students answers Assignment Sheet EL-05a

C-2 Check students answers Assignment Sheet EL-05b

C-3 Check students answers Assignment Sheet EL-05c

C-4 Check students answers Assignment Sheet EL-05d

C-5 Check students answers Assignment Sheet EL-05e

C-6 Check students answers Assignment Sheet EL-05f

C-7 Check students answers Assignment Sheet EL-05g

UNIT NO. EL-06

JECTIVE:

Read and interpret schematic diagrams.

GENERAL COMMENTS:

CHECK POINTS:

C-1 I. 1. Pictures of components
2. Listing of abbreviations used for components
3. Pictoral and schematic diagram
4. Circuit by circuit arrangement

C-2 1. 4, compressor, CFM, CH, IFM
2. IFR
3. By closing contact C
4. Compressor would stop running
5. Cooling
6. No

C-3 1. Compressor, outdoor fan motor, IF (3)
2. Stop compressor
3. Series
4. IF
5. Cooling thermostat
6. a-T, b-T, c-F, d-F, e-F.
7. Check students operational sequence

II. 1. Starting relay contacts would not open
2. Stop voltage flow to transformer
3. Contacter and FR
4. Internal
5. a-T, b-F, c-F
6. Check operational sequence

C-4 Check students wiring diagrams

UNIT NO. EL-07

**OBJECTIVE:**

Demonstrate an ability to correctly read an advanced schematic diagram.

**GENERAL COMMENTS:**

**CHECK POINTS:**

C-1
1. -4
2. -2
3. -CR
4. -manual cool switch and TSC
5. -2, closed, yes, OFM, C
6. -None
7. -3, no
8. -False
9. -Manual
10. -3

C-2
1. -2
2. -3. RVS, CR. IFR
3. -2nd TSH, TSO
4.
5.
6. -No
7. -No
8. -Start IFM
9. -Check students sequence

C-3
1. -RVR (N.O.), DFR, (N.C.)
2. -6. k, OL, OL, OL, HPCO, Contacts CR
3. -1 AS
4. -2, (1-N.C.),(1-N.O.)
5. -Yes, DFR contacts
6. -
7. Cut off
8. Decrease
9. Open C strips remain on
10. #2 Heater broken

C-4
1. Check students operational sequence
2. Pressure stat open (LP)
3. Bad HPS
4. Bad TDR

C-5 Check students wiring diagram

UNIT NO. EL-08

OBJECTIVE:

Demonstrate a knowledge of alternating current principles.

GENERAL COMMENTS:

CHECK POINTS:

C-1 Check answers on Assignment Sheet EL-08a and drawing Job Sheet EL-08a.

C-2 Check students readings and panel connections.

C-3 Check students readings and panel connections.

C-4 Check students readings and panel connections and answers to Assignment Sheet EL-08b.

UNIT NO. EL-09

OBJECTIVE:

Determine wire size and type per ampacity.

GENERAL COMMENTS:

CHECK POINTS:

C-1 Check results of data sheet.

C-2 Answers to Assignment Sheet EL-09a:

(1) See NEC section 100 for definitions. (2) Article 310-3.
(3) Article 424-22(b). (4) Article 424-20. (5) 424-63.
(6) Article 430-7. (7) Article 430-22. (8) Article 440-3.
(9) Article 440-13, 54, 55. (10) Article 440-5, 33.

Answers to Assignment EL-09b:

1. #3 THWN
2. #6 THWN
3. #14 TW
4. #8 TW
5. 3/0 THWN
6. #10 TW
7. #12 TW
8. 2/0 TW
9. #6 TW
10. 1/0 THWN

Check students wire sizing for Job Sheet EL-09b.

C-3 Check students wire sizing for Job Sheet EL-09c.

UNIT NO. EL-10

OBJECTIVE: Make a main panel connection for an air conditioner.

GENERAL COMMENTS:

CHECK POINTS:

C-1 Check size of disconnect switch and installation

C-2 Assignment Sheet EL-10a

1. See art. 100 definitions
2. same as one
3. Circuit breaker can be reset
4. 1-15 amps, 20, 25, 30, 35, 40, 45, 50, 55, 60, 70, 80, 90, 100, 125, 150, 175, 200
5. 0-30, 31-60, 61-100, 101-200

Job Sheet EL-10b

Check the students wiring connections

C-3 Assignment Sheet EL-10b

1. Clif in or bolt to buss
2. Piggy back breakers
3. Clip in for light duty, bolt on for heavy duty
4. Entire panel protection
5. Common -- 15, 20, 30, 40, 50, 60, 70, 80, 90, 100

Check students circuit breaker installation

C-4 Check students troubleshooting results

**UNIT NO.** EL-11

**OBJECTIVE:**

Install, wire and operate a shaded pole motor.

**GENERAL COMMENTS:**

**CHECK POINTS:**

C-1 (1) Starting strength in relationship to rotating (twisting effort). (2) 1. shaded pole, 2. split phase, 3. CSR & CS, 4. PSC, 5. three phase. (3) Low. (4) Three phase, CSR, PSC, split phase, shaded pole. (5) Cost of motors.

C-2 Check students identification.

C-3 Check students work.

C-4 Check students work.

C-5 Check students trouble shooting techniques.

UNIT NO. EL-12

OBJECTIVE: Install and operate a 230 volt split phase motor

GENERAL COMMENTS:

The following motors will need to be available for wiring and operation.

1. 110v split phase
2. 230 v split phase

CHECK POINTS:

C-1 Assignment Sheet EL-12a

1. See text
2. See diagram.

Connect the following diagram of a dual voltage to 110 volts and 230 volts.

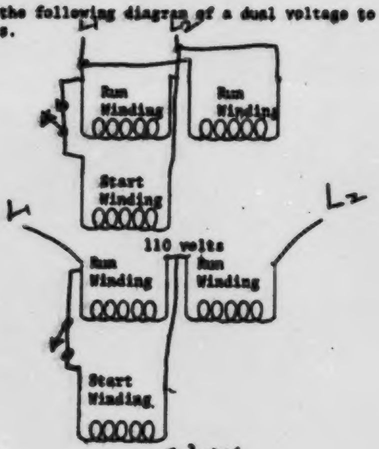

L1
L2
Run Winding
Run Winding
Start Winding
L1
L2
110 volts
Run Winding
Run Winding
Start Winding
230V

Figure E

UNIT NO. EL-13

OBJECTIVE:

Diagnose the condition and identify replacement capacitors on electric motors.

GENERAL COMMENTS:

Students will need a large assortment of different rated capacitors. For testing it would be best to keep on hand the different types of capacitor testers. However, at least two types of testers should be available for student use.

CHECK POINTS:

C-1 Check Assignment Sheet EL-13a.

C-2 Students should identify the running or starting, voltage, and micro-fared ratings of ten different capacitors on Job Sheet EL-13a.

C-3 Check Assignment Sheet EL-13b

C-4 Check Job Sheet EL-13b. Students should identify replacement capacitors for the rated capacitors in the job sheet.

C-5 (A) Check Job Sheet EL-13c. Students should have checked at least 20 capacitors with two types of testers.

(B) Check Job Sheet EL-13d. Students should determine the ratings of at least five capacitors. Check their results as recorded on the job sheet.

**UNIT NO.** EL-14

**OBJECTIVE:** Wire, install and operate (PSC) permanent split capacitor motors.

**GENERAL COMMENTS:**

Students will need one motor which can be used for disassembly. It will be most useful if this motor is operational. At best, three PSC multispeed motors, and at least two PSC hermetic motors will be needed for troubleshooting. These motors can be mounted or attached to various equipment.

**CHECK POINTS:**

C-1 Check Job Sheet EL-14a. Students should have disassembled, labeled, reassembled, wired, and operated a PSC multispeed motor. Students may need to refer to motor disassembly in EL-12. Check answers on Assignment Sheet EL-12a.

C-2 Check students diagnosis. Check answers on Assignment Sheet EL-12a.

C-3 Same as above

UNIT NO. EL-15

OBJECTIVE:

Wire, troubleshoot, and install open type capacitor-start motors.

GENERAL COMMENTS:

An open type capacitor-start motor should be available for disassembly. Also students will need the following motors for identification and troubleshooting.

CHECK POINTS:

C-1 Students should have disassembled and reassembled an open type CS motor. Ensure that students clearly understand the design and function of the components.

C-2 Students should have wired and operated the four types of CS motors:

1. 110v CS motor
2. 230v CS motor
3. Dual voltage CS motor
    a. 110v
    b. 230v

C-3 Students should troubleshoot the four types of CS motor. Make sure they have identified the problem for the repair of equipment.

**UNIT NO.** EL-16

**OBJECTIVE:**

Troubleshoot and hook up a CSR motor and starting relay

**GENERAL COMMENTS:**

Several residential Air Conditioning units with known malfunctions in starting relays and compressor motors should be available. The Air Conditioning units should represent the various types of relays used in the field, and at least one should be in need of a hard start kit.

**CHECK POINTS:**

C-1 Check the wiring conversion of the CS motor to the CSR motor.

C-2 Check operation of Air Conditioning unit after hard start kit has been installed.

C-3 Check student's findings against known conditions.

C-4 Check student's findings against known conditions.

UNIT NO. EL-17

**OBJECTIVE:**

Properly install and hook up 3-Phase Motors.

**GENERAL COMMENTS:**

At least three 3-Phase motors of single and dual voltage capabilities need to be available. Motors should have known problems such as shorted windings, open windings, etc. Also, three operable 3-Phase motors are needed.

**CHECK POINTS:**

C-1 Check results of Assignment Sheet EL-18a

C-2 Check student procedures and results.

C-3 Check results of Assignment Sheet EL-18a

C-4 Check Ohm readings and faults against known conditions.

**UNIT NO.** EL-18

**OBJECTIVE:**

Determine motor failure causes of shaded pole, split phase, PSC, CS, CSR and three phase motors.

**GENERAL COMMENTS:**

At least one motor of each type specified in the objective is needed. The motors should each have some known fault.

**CHECK POINTS:**

C-1 Check serial numbers against motor type.

C-2 Check student's recordings against known conditions.

UNIT NO. EL-19

OBJECTIVE:

Perform maintenance on electric motors including changing and lubricating bearings, aligning belts, and installing drive couplings.

GENERAL COMMENTS:

Motors with ball and sleeve bearings should be available for disassembly and lubrication.

CHECK POINTS:

C-1 1. X 2. X 3. X 4. X 5. X 6. X 7. X 8. X 9. O 10. X 11. O

C-2 Check motor serial numbers with types of bearings installed.

C-3 1. X 2. X 3. X 4. X

5. Belt parallel to pulleys and shafts of equipment parallel to each other.

6. Approximately one inch deflection when pressing down on center of belt.

C-4 1. Check for correct tension.
2. Check for correct listing of type.

C-5 1. Check for correct installation.
2. Check for correct alignment.

UNIT NO. EL-20

**OBJECTIVE:** Troubleshoot and change out a transformer on a small residential air conditioner.

**GENERAL COMMENTS:** Job sheet EL-21a: Have on hand several transformers and an AC unit with a faulty transformer. Prior to student work record the primary and secondary readings for Check Point C-1.
Job sheet EL 21b: A 208 volt A/C unit and the necessary transformer with known readings is necessary.

CHECK POINTS:

C-1 Check readings and compare to known conditions.
C-2 Check readings and compare to known conditions.

UNIT NO. EL-21

OBJECTIVE:

Test and install contactors and relays.

GENERAL COMMENTS:

Students will need an assortment of relays and contactors both on and off equipment for testing checking, classifying and troubleshooting. They should range from 24v coils to 208v coils.

CHECK POINTS:

C-1 Check Job Sheet EL-22a. Students should have disassembled and reassembled a contactor and a relay. Check the list and labeling for accuracy.

C-2 Check Job Sheet EL-22b. Students should diagram wire and operate three circuits of relays and contactors.
A. Relay controlling a ligh with a single-pole switch. (110v coil)
B. Relay controlling 110v fan motor with single-pole switch. (24v coil).
C. Contactor controlling 230v compressor with single-pole switch.

C-3 Check Job Sheet EL-22c. Students should troubleshoot five relays and five contactors and recorded specific information about each. Check the student's work.

UNIT NO. EL-22

**OBJECTIVE:**

Install and check low voltage and line voltage thermostats.

**GENERAL COMMENTS:**

Students will need access to an assortment of low voltage and line voltage thermostats. Equipment thermostats may be used. Dysfunctioning thermostats may be installed on equipment for troubleshooting purposes. Also different types of thermostats (bulb, limited, etc.) should be available. An operational clock thermostat will be needed for installation.

**CHECK POINTS:**

C-1 Check Job Sheet EL-23a. Students should have identified both low voltage and line voltage thermostats. Check the Job Sheet data chart to insure that recorded information is accurate.

C-2 Students should have installed at least one low voltage thermostat and one line voltage thermostat. Check the installation.

C-3 A. Check Job Sheet El-23d. Students should have checked and set the anticipator on three separate units.

C-4 A. Check Job Sheet EL-23e. Students have installed:

(1) Two stage cooling and two stage heating thermostat
(2) One stage cooling and two stage heating thermostat

B. Check Job Sheet EL-23f. A clock thermostat should have been installed. Check student's work.

C-5 Check Job Sheet EL-23g. Students were to troubleshoot thermostats on five separate units. Check their results.

UNIT NO. EL-23

OBJECTIVE:

Install, set and troubleshoot both high pressure switch (HPS) and low pressure switches (LPS).

GENERAL COMMENTS:

An assortment of high pressure switches and low pressure switches should be available for examination, setting and troubleshooting.

CHECK POINTS:

C-1 Check Job Sheet EL-24a. Students should identify and classify six pressure switches according to type, range, setting and switching action.

C-2 A. Check Job Sheet EL-24c. Students should set the LPS on a walk-in-cooler to maintain 35° Fahrenheit with a 5° Fahrenheit swing. They also should set the LPS on a commercial refrigerator to maintain 45° Fahrenheit with a 5° Fahrenheit swing.

C-3 Check Job Sheet EL-24e. Students should troubleshoot pressure switches for five units. They should have recorded faults and pressures for each in the chart.

**UNIT NO.** EL-24

**OBJECTIVE:**

Locate faulty overload switches.

**GENERAL COMMENTS:**

**CHECK POINTS:**

C-1 Check students identification of overload.

C-2 Check students diagnosis.

C-3 Check students installation of lock out relay.

C-4 Check students diagnosis.

UNIT NO. EL-25

OBJECTIVE:

Install and check Electro-Mechanical controls.

GENERAL COMMENTS:

CHECK POINTS:

C-1 Check students diagnosis.

C-2 Check students diagnosis.

C-3 Check students installation.

C-4 Check students installation and diagnosis.

C-5 Check students installation and setting.

**UNIT NO.** EL-26

**OBJECTIVE:**

Locate problems in magnetic starters.

**GENERAL COMMENTS:**

**CHECK POINTS:**

C-1 Check students identification of magnetic start parts.

C-2 Check students installation.

C-3 Check students installation.

C-4 Check students installation.

C-5 Check students installation.

UNIT NO. EL-27

OBJECTIVE:

Determine wire size and wire up a packaged air conditioner.

GENERAL COMMENTS:

CHECK POINTS:

C-1 Check students data sheet.

C-2 Check students installation.

UNIT NO. EL-28

OBJECTIVE:

Determine wire size and wire up a split system air conditioning unit.

GENERAL COMMENTS:

CHECK POINTS:

C-1 Check students data sheet

C-2 Check students installation

UNIT NO. EL-29

OBJECTIVE: Design and assemble an operating control system for an air cooled packaged unit.

GENERAL COMMENTS:

CHECK POINTS:

C-1 Orally quiz the students to make sure they understand the components in the schematic

C-2 Check wiring connections

C-3 Check wiring diagram

C-4 Check wiring connections

C-5 Check wiring diagram

C-6 Check wiring connections

**UNIT NO.** EL-30

**OBJECTIVE:** Design and construct an advanced control panel.

**GENERAL COMMENTS:**

**CHECK POINTS:**

C-1 Check wiring connections

C-2 Check wiring diagram

C-3 Check wiring connections

C-4 Check wiring diagram

C-5 Check wiring connections

UNIT NO. EL-31

OBJECTIVE:

Identify problems in basic electrical control systems.

GENERAL COMMENTS:

CHECK POINTS:

C-1 Check students diagnosis.

C-2 Check diagnosis

C-3 Check students troubleshooting techniques

UNIT NO. EL-32

OBJECTIVE:

Identify problems in the electrical control systems.

GENERAL COMMENTS:

CHECK POINTS:

C-1 Check answers to questions

UNIT NO. EL-33

OBJECTIVE:

You will be able to service solid-state control circuits using, as is required by the specific system being serviced, either a: Whole-System Tester; High Resistance Voltmeter; or Continuity Tester.

GENERAL COMMENTS:

Completion of this unit requires:

a. Common shop tools
b. Whole-System Tester
c. High Resistance Voltmeter
d. Continuity Tester
e. A system having solid-state control circuits and requiring a Whole System Tester for alignment or fault isolation.
f. A system having solid state control circuits and suitable for troubleshooting by either a High Resistance Tester or a Continuity Tester.

CHECK POINTS:

(See Attachments)

C-1 Title: Identifying Solid-State Devices and Solid-State Servicing Procedures.

The student should supply answers like or indicative of the following responses.

1. production, use, and storage
2. sensor, zone
3. low current
4. box or rectangle - sensor, controlled units
5. Mini-computer 4
   Logic Board 6
   Printed Circuit Board 2
   Integrated Circuit 1
   Chip 3
   Chip Board 5
   Module 8
6. (different/similar)
7. Check it with a Tester.
8. Whole-System Tester
9. High Resistance Voltmeter
10. Do not short the leads of IC's or other components on the module.

C-2 Instructor Check of Job Sheet A.

Part I: Compare student response to the conditions you know exist in the project.

Symptoms:

Test Required:

Test Results:

Repair or Replace Decision:

Depending upon your review of student's performance (observation) and/or responses, have the student repeat Part I on another system or correct any minor errors which may exist and direct to Part II.

Part II: Review student's performance against shop standard and depending upon outcome, either direct that the project be repeated or instruct to proceed to Job Sheet EL-33b.

C-3 Instructor Check of Job Sheet B.

Part I: Compare student response to the conditions you know exist in the project.
Symptoms: ______________________________________________
______________________________________________
______________________________________________
Test Required: ______________________________________________
______________________________________________
______________________________________________
Test Results: ______________________________________________
______________________________________________
______________________________________________
Repair or Replace Decision: ______________________________
Depending upon your review of student's performance (observation) and/or responses, have the student repeat Part I on another system or correct any minor errors which may exist and direct to Part II.

Part II: Review student's performance against shop standard and depending upon outcome, either direct that the project be repeated or instruct to proceed to Job Sheet EL-33c.

C-4 Instructor Check of Job Sheet C.

Part I: Compare student response to the conditions you know exist in the project.
Symptoms: ______________________________________________
______________________________________________
______________________________________________
Test Required: ______________________________________________
______________________________________________
______________________________________________
Test Results: ______________________________________________
______________________________________________
Repair or Replace Decision: ______________________________
Depending upon your review of student's performance (observation) and/or responses, have the student repeat Part I on another system or correct any minor errors which may exist and direct to Part II.

Part II: Review student's performance against shop standard and depending upon outcome, either direct that the project be repeated or instruct to proceed to next activity.

# MAJOR BLOCK

# REFRIGERATION

REF 1 -- REF 38 Secondary

REF 1 -- REF 25 Post Secondary

UNIT NO. REF-01

OBJECTIVE:

Identify orally and in writing the many career opportunities available in refrigeration and related fields.

GENERAL COMMENTS:

CHECK POINTS:

C-1 Discuss the types of systems the student listed, trying to improve on the list.

C-2 Discuss with the student the opportunities listed. Correct any errors found and stimulate the student's thoughts if the list is found lacking.

C-3 Make sure the student understands the training which will be received in the program and the individual student responsibilities in receiving it.

UNIT NO. REF-02

**OBJECTIVE:**

Identify and practice safe working habits in the laboratory and in the workplace.

**GENERAL COMMENTS:**

**CHECK POINTS:**

C-1
1. Water
2. Tested, marshall
3. Fire extinguisher
4. Control, fire
5. Extinguisher, safety
6. Running, injuries
7. Goggles, torches, or drillers

C-2 Check students Assignment Sheet for first aid remedies for injuries.

C-3
1. Distractions
2. Room, breathing
3. System, leaks, and electronic leak detector
4. Water, extrocuted
5. Safe-workmanship and accidents
6. Tools
7. Off
8. Uniforms, accidents
9. Wet, grease and electricity
10. Match or smoke
11. Gas or oil

C-4 Check students Assignment Sheets for safe working condition notations.

UNIT NO. REF-03

OBJECTIVE: Demonstrate an understanding of the basic concepts of refrigeration.

GENERAL COMMENTS:

CHECK POINTS:

C-1 Check Assignment Sheet REF-03a

(1) Heat, Space

(2) Energy

(3) Cold

(4) Cold

(5) Higher, Lower

(6) Compressor

(7) Thermostat

(8) Thermometer

(9) Fahrenheit

(10) Ambient

(11) Latent

(12) Sensible

(13) B.T.U.

(14) Molecules

(15) B.T.U.

(16) Solid, Liquid, Gas

C-2 Check student's progress on Assignment Sheet b

C-3 Check student's performance on Assignment Sheet c

(1) Energy and by difference in temperature.

(2) By removing the heat from the area.

(3) It is the smallest physical unit, or whole part of any substance.

(4) Latent heat.

(5) Thermometers and thermostats.

(6) Solids, liquids, gases.

UNIT NO. REF-04

OBJECTIVE:

Demonstrate an understanding of the basic refrigeration cycle

GENERAL COMMENTS:

CHECK POINTS:

C-1 Answers to the Assignment Sheet REF-04a
1. metering device and compressor
2. evaporator
3. the condenser
4. cycle
5. vapor
6. compressor
7. sealed
8. small
9. liquid
10. compressor

C-2 Student should be able to name the four major components of the refrigeration system and give a brief description of each.

C-3 Student should be able to explain orally the complete refrigeration cycle.

C-4 Answers to Assignment Sheet REF-04b
1. false
2. false
3. false
4. true
5. 1. compressor 2. condenser 3. evaporator 4. expansion valve
6. moist
7. sight glass
8. suction line
9. vapor
10. container or cylinder

UNIT NO. REF-05

OBJECTIVE:

Identify and examine the proper tools used in refrigeration work.

GENERAL COMMENTS:

Job Sheet REF-05a: Make sure the tools called for are available. Demonstrate to student the use of the bench grinder and emphasize eye protection.

CHECK POINTS:

C-1 Check tools against list. Show the student the proper method of using the bench grinder.

C-2 Check answers to Assignment Sheet REF-05a.

(1) Your hand is easier to slip when pushing, thus causing injury to the mechanic.

(2) Open end, or flate nut wrench.

(3) In case tool should short out, the operator will be protected.

(4) The flat screwdriver has one flat blade and the phillips has a tip which fits a recessed cross in the head of the screw.

(5) To remove hex screws from motor pulleys.

(6) The cutter cuts a straight smooth cut and does not bend the tubing.

UNIT NO. REF-06

**OBJECTIVE:**

Replace threads.

**GENERAL COMMENTS:**

Some type of thread block is needed to drill holes in and tap out.

**CHECK POINTS:**

C-1 Answers to Assignment Sheet REF-06a:
(1) heat; (2) nut; (3) stove bolt, machine bolt and toggle bolt; (4) toggle bolt; (5) carriage; (6) screw; (7) set; (8) phillips, flat; (9) hex head; (10) pop rivet; (11) regular: (12) hex head; (13) wood; (;4) pan; (15) thin; (16) hex.

C-2 Check the students ability to discriminate between the many types of nuts and bolts.

C-3 Check the student's ability to thread pipe.

C-4 Check the student's ability to repair damaged threads.

UNIT NO. REF-07

OBJECTIVE:

Identify the different types of pipe and tube fittings used in refrigeration systems.

GENERAL COMMENTS:

Several samples of all the types of fittings used in refrigeration work must be on hand.

CHECK POINTS:

C-1 Student should have five separate piles of fittings. Determine if the student can properly identify and size as shown on Job Sheet REF-07a.

C-2 Flare and sweat
Hard drawn copper
The tubins is flexible
90°
Soft copper tubing
95-5

UNIT NO. REF-08

OBJECTIVE:

Cut and bend soft and hard copper tubing.

GENERAL COMMENTS:

An assortment of different sizes of soft and hard copper tubing. Job Sheet REF-08a can utilize many scrap pieces of copper left over from other training activities.

CHECK POINTS:

C-1 Student should have 6 pieces of tubing 3" long. Each piece should be reamed, flared, and swaged with flare nut in place. Job Sheet REF-08a.

C-2 Check answers to Assignment Sheet REF-08a.
1. To joint two pieces of copper tubing the same size.
2. The same distance as the tubing wide.
3. Small tubing cutter, it is the easiest and neater than a hack saw.
4. Spring tube and lever type.
5. 45° angle.

C-3 Check the operations for Job Sheet REF-08b. Look for the following:
a. burrs from cutting
b. 90° bend
c. 180° bend
d. crimped tubing

UNIT NO. REF-09

OBJECTIVE:

Swage, clean, flux and soft solder copper tubing using 50-50 and 95-5 solders.

GENERAL COMMENTS:

CHECK POINTS:

C-1 Observe flame and answer any questions students may have.

C-2 Inspect swaging and cleaning. Check to see if the flux is uniform. Answer any questions the student may have at this time. Remind student that he or she will need these joints on the next exercise.

C-3 Instructor should check and see if student is holding torch properly and also check joints for neatness and pressure. The tubing should be hooked up to water pressure and checked for leaks. Have student repeat job until he or she has achieved a craftsman like soldered joint.

UNIT NO. REF-10

**OBJECTIVE:**

Demonstrate the proper technique for silver brazing on refrigeration piping.

**GENERAL COMMENTS:**

Students will be using torches for brazing. The instructor should make sure the student is well versed in safety precautions.

**CHECK POINTS:**

C-1 Answers to Assignment Sheet REF-10a

1. brazing cooling
2. true
3. liquid fitting
4. 1100°F 1200°F
5. torch lighter or sparker
6. false
7. One-quarter
8. true
9. A. Blue cone with reddish-purple tip
10. solder or braze
11. left

C-2 Check the students'work for neatness pointing out any apparent flaws in the students'technique.

UNIT NO. REF-11

OBJECTIVE:

Demonstrate a knowledge of characteristics of Refrigerants, Handling, Transfer, Weighing, and Measuring.

GENERAL COMMENTS:

CHECK POINTS:

C-1 1. remove oil, create low temperatures in components

2. sight glass, pressure, weighing, frost

3. vapor or liquid charging

4. B

5. It is toxic and flammable

6. discharged into atmosphere, stored in system, stored in drums

7. false leave room for vapor pressure

8. hot, expansion

9. filter/dryer

C-2 check results from known data

C-3 check students procedure for safety and accuracy.

UNIT NO. REF-12

OBJECTIVE:

Install and use at least two types of access (service) valves.

GENERAL COMMENTS:

Job Sheet REF-12a requires a refrigeration system with a permanently installed stem type service valve. Job Sheet REF-12b requires installation of a soldered on schrader valve to the compressor stub.

CHECK POINTS:

C-1 Check answers on Assignment Sheet REF-12a

C-2 Observe student during charging process. Allow the job to be repeated if necessary.

C-3 Inspect soldered schrader valve and have student repeat job if needed.

UNIT NO. REF-13

OBJECTIVE:

Calibrate a set of gauges at O-PSIG and check against gas in a given tank by corresponding temperature to pressure.

GENERAL COMMENTS:

CHECK POINTS:

C-1 Check students answers on assignment sheet REF-13a

C-2 Check the student's knowledge of the operation of a manifold gauge. Ask the student to name the parts and explain how to "crack" a valve.

C-3 Ask the student to verbally give the step-by-step procedures on the correct way to zero the gauges.

UNIT NO. REF-14

OBJECTIVE: Install and use refrigeration manifold gauges.

GENERAL COMMENTS: Operative open type refrigeration system is needed.

CHECK POINTS:

C-1 Observe student using manifold gauges on Job Sheet REF-14a.

UNIT NO. REF-15

OBJECTIVE:

Use the vacuum pump to evacuate a refrigeration system.

GENERAL COMMENTS:

CHECK POINTS:

C-1 Check the students answers to Assignment Sheet REF-15a.

C-2 Check the students ability to triple vacuum a system.

C-3 Check the students ability to deep vacuum a system.

C-4 The answers to Assignment Sheet REF-15a are on the following pages.

## ANSWERS TO ASSIGNMENT SHEET REF-15a

1. a. 3
   b. 8
   c. 1
   d. 9
   e. 4
   f. 10
   g. 6
   h. 5
   i. 2
   j. 7
   k. 11

2. a. To remove noncondensables from the system
   b. To remove oil trapped refrigerant
   c. To remove moisture from the system

3. b, c, e, g

4. b, c, e

5. Description should include:
   a. Moisture is removed in a vapor state
   b. Boiling temperature decreases as the pressure decreases
   c. Increasing the ambient temperature will decrease evacuation time

6. a. H
   b. L
   c. L

7. a. Check to see if the pump will pull a vacuum on itself
   b. Change oil after every extensive evacuation
   c. Keep pump clean
   d. Keep caps on the inlet and outlet ports
   e. Do not discharge refrigerant through the vacuum pump
   f. Do not operate vacuum pump with a low oil level

8. Description should include:

   a. Compound gauge

      1) Used in conjunction with other vacuum indicators

      2) Accurate to 25" Hg

      3) Should not be sole indicator

      4) Vacuum is read on the 0 to 30" part of the gauge

   b. Mercury manometer

      1) Accurate below 25" Hg

      2) Keep capped when not in use

      3) Must be kept in vertical position when using

      4) Vacuum is read directly

      5) Will indicate a leak or moisture still in the system after the pump is shut off.

         a) No change in reading indicates the system is okay

         b) Reading returns to atmospheric pressure indicates a leak

         c) Slight change in reading indicates moisture still in the system

   c. Electronic vacuum gauge

      1) Accurate below 29" Hg

      2) Gives accurate readings to 50 microns

      3) Use with high vacuum pumps

      4) Durable enough for field use

9. Performance skills evaluated to the satisfaction of the instructor.

UNIT NO. REF-16

OBJECTIVE: Install at least two in-line accessories according to manufacturers specifications (filter driers, liquid indicators, etc.)

GENERAL COMMENTS:

CHECK POINTS:

C-1 Check written answers on Text Assignment REF-16a

C-2 Check answers on Assignment REF-16~~a~~b

C-3 Inspect for correct installation.

C-4 Inspect for correct installation

C-5 Inspect for correct installation

UNIT NO. REF-17

OBJECTIVE: Demonstrate the ability to leak test by, soap bubbles, halide torch, and electronic detector.

GENERAL COMMENTS:

CHECK POINTS:

C-1 Observe student's procedure and techniques used in testing for leaks

C-2 Observe student's precedure and techniques used in testing for leaks

C-3 Observe student's precedure and techniques used in testing for leaks

C-4 Observe student's procedure and techniques used in testing for leaks

UNIT NO. REF-18

OBJECTIVE:

Demonstrate the ability to charge a unit by vapor and by liquid, using charts and manifold gauges, showing knowledge of the use of the sight glass, frost back and weighing refrigerant into unit.

GENERAL COMMENTS:

CHECK POINTS:

C-1 1. a. 5
- b. 4
- c. 1
- d. 2
- e. 3

2. a. Advantages
   - (1) Easiest method of adding refrigerant to a charge system.
   - (2) Liquid refrigerant cannot enter suction side of the compressor.

   b. Disadvantages
   - (1) Slow process for adding large quantities of refrigerant.
   - (2) High drum pressure could wash out compressor oil.

3. a. X
- b. 0
- c. 0

C-2 Check student's progress and vapor charging techniques.

C-3 Check student's progress and liquid charging techniques.

UNIT NO. REF-19

OBJECTIVE: The student will be able to troubleshoot a hermetic compressor for mechanical problems accurately and safely.

GENERAL COMMENTS:

CHECK POINTS:

C-1 Check answers to Assignment Sheet

1. C, F
2. D
3. A, B
4. E

C-2 Check the students answers to Job Sheet REF-19a.

C-3 Check the students answers to Job Sheet REF-19b.

UNIT NO. REF-20

OBJECTIVE:

To identify a faulty condenser and remove and replace same.

GENERAL COMMENTS:

Job Sheet REF-20a: Select an operational unit for the student to remove and replace a condenser on.

CHECK POINTS:

C-1 (A-1) Convection (static)
(A-2) Air cooled (forced convection)
(A-3) Shell & tube
(A-4) Evaporative
(A-5) Tube within a tube

C-2 (1) Insure safety precautions are observed throughout job task
(2) Insure proper tools are used for all phases of removal and installation
(3) Check condenser for damage during and after installation
(4) Observe evacuation, charging and leak test for proper procedure
(5) Check unit for proper operation after job completion

UNIT NO. REF-21

OBJECTIVE:

To identify a faulty evaporator and remove and replace same.

GENERAL COMMENTS:

Job Sheet REF-21a: Select an operational unit for the student to remove and replace a condenser on.

CHECK POINTS:

C-1 (A) Fin

(B) Shelf Evaporator

(C) Shell

C-2 (1) Insure safety precautions are observed throughout job task.

(2) Insure proper tools are used for all phases of removal and installation.

(3) Check evaporator for damage during and after installation.

(4) Observe evacuation, charging and leak test for proper procedure.

(5) Check unit for proper operation after job completion.

**UNIT NO.** REF-22

**OBJECTIVE:** Identify, troubleshoot and install an automatic expansion valve.

**GENERAL COMMENTS:** Make sure units are available that utilize an automatic expansion valve i.e., refrigerators, water coolers, etc.

**CHECK POINTS:**

C-1 Thermostatic Expansion Valve - controls the flow of refrigerant by maintaining a constant superheat at the end of the evaporator coil. Automatic Expansion Valve - maintains constant outlet pressure regardless of changes in inlet liquid pressure, load or other conditions.

C-2
1. Insure safety precautions are observed throughout the job task.
2. Insure that proper tools and equipment have been checked out and are used properly.
3. Make sure unit is operated properly and that the system is stabilized before readings were taken.
4. Insure the student is able to explain why and how he made each operational check.
5. Insure all tools and equipment are returned to the tool room.

C-3
1. Insure safety precautions are used throughout the job task.
2. Insure the proper tools and equipment have been checked out and used properly.
3. Check expansion valve for damage during removal.
4. Observe evacuation, charging and leak test for proper procedure.
5. Check unit for proper operation after job completion.

C-4 Check results of assignment sheet REF-22b.

**UNIT NO.** REF-23

**OBJECTIVE:** Identify, remove, and replace a faulty capillary tube.

**GENERAL COMMENTS:** This job may require replacement using a new tube. Explain to learner the necessary measurements that must be made.

**CHECK POINTS:**

C-1
1. Insure safety precautions are observed throughout job Task.
2. Insure proper tools are used in all phases of removal and installation.
3. Check capillary tube for damage during and after installation.
4. Observe evacuation, charging and leak test for proper procedure.
5. Check unit for operation after job completion.

UNIT NO. REF-24

**OBJECTIVE:**

Identify, troubleshoot and install a thermostatic expansion valve.

**GENERAL COMMENTS:**

This unit will require a refrigeration system utilizing a TEV.

**CHECK POINTS:**

C-1 Automatic Expansion Valve - maintains constant outlet pressure regardless of changes in inlet liquid pressure, load or other conditions.
Thermostatic Expansion Valve - controls the flow of refrigerant by maintaining a constant superheat at the end of the evaporator coil.

C-2
1. Insure safety precautions are ovserved throughout the job task.
2. Insure that proper tools and equipment have been checked out and are used properly.
3. Make sure unit is operated properly and that the system is stabilized before readings were taken.
4. Insure the student is able to explain why and how he made each operational check.
5. Insure all tools and equipment are returned to the tool room.

C-3
1. Insure safety precautions are used throughout the job task.
2. Insure the proper tools and equipment have been checked out and used properly.
3. Check expansion valve for damage during removal.
4. Observe evacuation, charging and leak test for proper procedure.
5. Check unit for proper operation after job completion.

UNIT NO. REF-25

OBJECTIVE:

Safely troubleshoot and repair the refrigeration system

GENERAL COMMENTS:

CHECK POINTS:

C-1 (1) Insure proper safety precautions are observed throughout the job task.
(2) Insure proper tools are used for all phases of the troubleshooting procedure.
(3) Insure that the student can explain the procedure used to locate the problem.

C-2 (1) Insure that proper safety precautions are observed throughout the job task.
(2) Insure the student can explain fully the sequence of steps required to repair the unit.
(3) Check the manual student is using and determine if it is the proper one for the work.
(4) Insure the task was completed in a safe, neat, and professional manner.

C-3 (1) Insure student operates unit in accordance with manufacturer's recommendations.
(2) Insure student takes gauge readings at the proper location.
(3) Insure student is capable of explaining what all readings mean.

**UNIT NO.** REF-26

**OBJECTIVE:**

Install a window air conditioning unit according to manufacturer's specifications.

**GENERAL COMMENTS:**

A window unit with manufacturer's installation instructions and a mock-up window is necessary.

**CHECK POINTS:**

C-1 Check to see if student can identify W/AC parts and discuss any comments the student has written.

C-2 Check W/AC for proper installation.

C-3 Student should explain to you how unit works and how to do minimum customer maintenance on the window unit.

UNIT NO. REF-27

OBJECTIVE:

Inspect, and perform a pre-season start up for an air conditioning window unit.

GENERAL COMMENTS:

A mounted, serviceable window air conditioning unit should be used with this task.

CHECK POINTS:

C-1 Check students answers to Assignment Sheet REF-28a

(A) unit not tilted
(B) worn cord
(C) crack
(D) window lock bracket missing
(E) rail seal missing
(F) dirty filter

C-2 (A) check repairs to installation
(B) check cleanliness of coils and filter
(C) check to see if fan motor oiled
(D) check final work for correct seals
(E) check checklist

UNIT NO. REF-28

OBJECTIVE:

Diagnose a compressor burnout and replace the compressor.

GENERAL COMMENTS:

Three compressors for window air-conditioners will be needed for this activity: 1) operational, 2) grounded windings to dome, and 3) open winding.

CHECK POINTS:

1. Check to see that the student has made the appropriate diagnosis. If the wrong diagnosis was made, have the student return to the compressors and repeat the procedures for diagnosing compressor burnout.
2. Check students air-conditioner for proper operation.

UNIT NO. REF-29

OBJECTIVE:

Evacuate and charge window air-conditioners.

GENERAL COMMENTS:

Two or three operational window air-conditioners will be needed for this activity. The least expense may be involved by taking in live work for this activity.

CHECK POINTS:

1. Ask the student for an oral explanation of procedures for triple evacuation. Check to see that holding charge is 10 pounds per square inch guage.
2. Check unit for proper charge (temperature, pressure, and touch method).
3. Check unit for proper charge (Dial-a-charge).

UNIT NO. REF-30

OBJECTIVE: Troubleshoot and replace a fan and fan motor on a window air-conditioner.

GENERAL COMMENTS: To perform this activity the student will need to test electric motors (shaded pole and psc) to find problems both in mechanical operation (bearings, fan) and electrical operation (open windings, grounded, and shorted). Dysfunctional motors might be useful for this part of the activity. Instructors may or may not require the "direct test". If so, the kit will be needed. One such kit is the Robinair Kit No. 12710.

CHECK POINTS:

C-1 Check to see if student can tell difference in fan motors

C-2 Check student to see if he can use VOM to check continuity of winding

C-3 Check student to see if he can direct test motor using start kit or cord set.

C-4 Check for proper installation of the fan motor. This is an important assignment because if the fan is improperly removed or replaced an overall bad installation will be the eventual result.

UNIT NO. REF-31

OBJECTIVE: Troubleshoot the refrigeration cycle of a window air conditioner

GENERAL COMMENTS: The problem should be totally mechanically in relation to refrigeration cycle. (Suggestions - kinked cap tube).

CHECK POINTS:

C-1 Check student's findings. Discuss what should be happening in a properly operating unit.

C-2 The student will describe what he or she thinks is wrong. Give assistance as necessary.

UNIT NO. REF-32

OBJECTIVE:

Locate electrical problems in a window air conditioner.

GENERAL COMMENTS:

Some method to tag or label components will be needed. When assigning a malfunctioning air conditioner to troubleshoot, relate it as a customer complaint.
A window/air conditioner with a known electrical problem(s) will be needed.

CHECK POINTS:

C-1 Check to see if student can identify electrical components by proper name.

C-2 Check to see if student understands how to read the W/AC wiring diagram. Check to see if student can point out wire colors of different speeds on fan and C-R-S on compressor. Question student on wiring diagram thoroughly.

C-3 Check to see if student diagnosed problem and suggested correct repairs.

UNIT NO. REF-33

OBJECTIVE:

The student will recognize the basic components of the refrigerator and freezer refrigeration cycle and can describe the operation of these parts.

GENERAL COMMENTS:

Job Sheet REF-33a: Instructor should have hot wire relay opened and overload housing partially removed.

Assignment Sheet REF-33a: Supply student with colored markers as needed.

Assignment Sheet REF-33b: Provide student with labels or tags and have the necessary refrigerators for this assignment.

CHECK POINTS:

C-1 Check for correct drawing colors and information

C-2 Check that student has identified parts correctly

C-3 Check results of job. See that student understands operation of components.

UNIT NO. REF 34

OBJECTIVE: Evacuate and charge domestic refrigerator and freezer systems.

GENERAL COMMENTS: Job Sheet REF-34a requires a refrigerator with a pre-cooler. Job Sheet REF-34d requires a refrigerator charged system with a known leak.

CHECK POINTS:

C-1 (a) Student should properly identify compressor and all tubing connections to the compressor
(b) Access valve should be properly installed in the most convenient place for servicing.

C-2 Student should be able to demonstrate how to triple evacuate a system.

C-3 Student should be able to demonstrate how to deep evacuate a system.

C-4 Student should be able to locate the leak.

C-5 Student should be able to demonstrate how to charge with a liquid.

C-6 Refrigerator should have full frost pattern and suction line at compressor should not be cold. Suction pressure should be 3 psi.

C-7 Student should leave enough tubing so servicing can be done at a later date. End of tubing should be filled with solder with no leaks indicated by a visual inspection.

UNIT NO. REF-35

OBJECTIVE:

Troubleshoot the refrigeration cycle in a refrigerator or freezer.

GENERAL COMMENTS:

Any area of the job sheet that the student is unable to follow through and complete, the instructor should assign review work as deemed necessary. Refrigerator should be a two door in proper working condition. Thermostat turned to coldest position. A door should be placed out of adjustment (hinge side warped, hinge shimmed out or something inside keeping door from closing completely). Process tube should be long enough so that the procedure of using an access valve attaching, removing and sealing can be done several times before having to be replaced.

CHECK POINTS:

C-1 a. Temperature should be set correctly.
b. Door should be adjusted properly
c. Access valve removed and pierced hole properly sealed.

C-2 Diagnostic list by student should indicate he/she is thinking the problem through.
Proper diagnosis of problem should be indicated.
Refrigeration system should be operating properly.

**UNIT NO.** REF-36

**OBJECTIVE:** Test and repair fans, fan motors, switches, and connections.

**GENERAL COMMENTS:** For Job Sheet a, the equipment needed is: 1) assorted fan motors with known problems and at least one good motor. 2) assorted switches with known problem and at least one good switch. 3) components and simple circuit mounted on a board (system should operate). 4) all items should be numbered. 5) checklist showing problem with each no. item.

**CHECK POINTS:**

C-1 Student list of test information should show that he/she is able to use a volt meter and ohmmeter to test the components supplied in job sheet.

C-2 The fan motor should be fastened securely and the fan blade should be aligne for proper movement of air and no vibration.

UNIT NO. REF-37

OBJECTIVE: Troubleshoot a compressor burnout on a refrigerator or freezer

GENERAL COMMENTS: For Job Sheet REF-37a the student will test compressors with a VOM. Have 10 compressors available for students to check. These can be on a table or on shelves. The compressors should be numbered with a list of known problems for checking student's results. Several (at least two) of the compressors should operate.

CHECK POINTS:

C-1 Student's answers should coincide with answers provided here. Have student review any missed. Also, discuss the concept with the student and assign additional work (on paper) if needed.

ANSWERS TO ASSIGNMENT SHEET REF-37a

1. A) start
   B) run
   C) common

2. A) common
   B) start
   C) run

3. A) start
   B) run
   C) common

4. A) common
   B) run
   C) start

5. A) run
   B) common
   C) start

6. A) start
   B) run
   C) common

7. A) common
   B) start
   C) run

8. A) common
   B) start
   C) run

9. A) common
   B) start
   C) run

C-2 (1) Student should have selected only the compressor with good windings to test.
(2) Of these he/she should have been able to run the good compressor.
(3) Discuss and review if necessary.

C-3 (1) Bolted down properly.
(2) Plumbing should be neat.
(3) Charging point should be properly sealed.
(4) Refrigerator should run and maintain proper temperature indicating electrical connections and charge are correct.

UNIT NO. REF-38

**OBJECTIVE:**

Diagnose and locate problems in refrigerators and freezers.

**GENERAL COMMENTS:**

The refrigerator used in the Job Sheet REF-28a does not need to have a compressor but all other components should be operatable.

**CHECK POINTS:**

C-1 (1) Check results of Job Sheet.
(2) Student should be able to test refrigeration components.
(3) Instructor should assist student in this area as needed by discussion, additional assignments or review as deemed necessary.

C-2 (1) Was students solution to the problem correct.
(2) Were the steps taken logical.
(3) Was work neat.

## MAJOR BLOCK

## RESIDENTIAL ELECTRICAL WIRING

REW -01 -- REW-13 Secondary

UNIT NO. REW-01

OBJECTIVE:

Install a 115v appliance outlet.

GENERAL COMMENTS:

CHECK POINTS:

C-1 (A) Check to see that the student has recorded the correct amperage rating from each appliance and listed the correct NEC requirement for each.

(B) Student should have drawn and labeled the breaker size, wire size and identified wires as to hot, neutral and ground.

C-2 Student should have selected breaker size, wire size, and correct amperage rating for the assigned appliance to wire an appliance outlet and distribution panel. Check to determine if wiring is neat and orderly in both panel and outlet. Check for:

1. Properly stripped wires
2. Amount of wire from boxes
3. Terminal connections

UNIT NO. REW-02

OBJECTIVE:

Install a convenience outlet

GENERAL COMMENTS:

CHECK POINTS:

C-1 Check Assignment Sheet REW-02a. Student should have drawn and labeled the hot, neutral and ground.

C-2 Check the student's hook up. Four convenience outlets should be wired into the distribution panel. Check the following:

(A) Six inches of excess cable on each outlet. (Wire should be 12-2 wg).

(B) Ends of wire should be stripped only enough to make eyes for terminals.

(C) Wires should be tightly clamped into boxes. (Not too tight).

(D) Panel should be neatly wired. (90° turns etc.)

(E) Test each outlet.

UNIT NO. REW-03

OBJECTIVE:

Design and install simple lighting circuits.

GENERAL COMMENTS:

CHECK POINTS:

C-1 The drawings for this Assignment Sheet may differ; however, all should meet the National Electric Code standard and be operable.

C-2 Check the installation of the circuit designed in Assignment Sheet REW-03a.

C-3 Check the circuit design for correctness. The student will install this circuit in the lab. Check the installation.

UNIT NO. REW-04

OBJECTIVE:

Design and install split and switched receptacles.

GENERAL COMMENTS:

CHECK POINTS:

C-1 Student should have drawn in wires on Assignment Sheet REW-04a.

- A. Figure B should be designed where receptacle portion of the device is hot and not affected by the control switch.
- B. Figure C should be designed where each portion of the receptacle is fed by a separate circuit.

C-2 Student should have assembled a distribution panel, two outlets and a light. Three circuits should exist. One circuit feeds the combination switch and receptacle and the other two circuits should supply the receptacle. Check each of the wired devices to determine if they are operating correctly.

UNIT NO. REW-05

OBJECTIVE:

Design and install one and two button door bell circuits.

GENERAL COMMENTS:

Students will need several low voltage transformers in order to select the appropriately rated transformer (16v)

CHECK POINTS:

C-1 Check correct wiring diagram on Assignment Sheet REW-05a. Student should have drawn in wires for one and two bell circuits and labeled all parts.

C-2 Check list of parts and wiring for a one button door bell. All wiring should be neat with a 16v transformer.

C-3 Check list of parts and wiring for a two station door bell.

UNIT NO. REW-06

OBJECTIVE:

Design and install a three-way switch.

GENERAL COMMENTS:

Students will need the components to wire a three-way switch.

1. Two lights and boxes
2. Wire - 12-2 WG and 14-3.
3. At least two three-way switches

CHECK POINTS:

C-1 Check Assignment Sheet REW-06a. Students should have drawn in circuitry for a three-way switch.

C-2 Students should have wired the three-way switches identified on Job Sheet REW-06a. Circuit should be checked for proper operation, splices, neatness, etc.

C-3 Check the circuitry on Job Sheet REW-06b. Again check for proper operation, splices, neatness, etc.

UNIT NO. REW-07

OBJECTIVE:

Install 230v circuits from the service entrance panel to a junction box, flush mount receptacle, and a surface mount receptacle.

GENERAL COMMENTS:

Students will need an assortment of 230v appliance receptacles. At least one of each type should be available. Also an assortment of different wire types should be available along with sufficient breaker panels.

CHECK POINTS:

C-1 Check the chart for correct answers. Inspect the components the student has selected.

C-2 Make sure students drawing is correct. Check components the student has selected and his/her completed work.

C-3 Make sure students drawing is correct. Check components the student has selected and his/her completed work.

C-4 Make sure students drawing is correct. Check components the student has selected and his/her completed work.

**UNIT NO.** REW-08

**OBJECTIVE:**

Design and install a temporary service entrance.

**GENERAL COMMENTS:**

**CHECK POINTS:**

C-1
1. weather head
2. mast
3. meter socket
4. the ground lug
5. load side terminal
6. line side terminal
7. conduit
8. main breaker
9. ground buss
10. the hot buss bar
11. drip loop
12. a lock nut

C-2 The student must have installed a service entrance meeting power company codes.

UNIT NO. REW- 9

OBJECTIVE:

Install and wire service entrance cable and main panel.

GENERAL COMMENTS:

CHECK POINTS:

C-1 Answers will vary according to availability distribution panels.

C-2 Check the student's grounding system design. Also, check the student's installation of the distribution panel.

UNIT NO. REW-10

**OBJECTIVE:**

Install a temporary service.

**GENERAL COMMENTS:**

**CHECK POINTS:**

C-1 Student must have designed a service pole meeting the specifications listed on the Assignment Sheet.

C-2 Student will install the temporary service pole designed in the previous Assignment Sheet.

UNIT NO. REW-11

**OBJECTIVE:**

Identify the graduations of standard measurement and measure electrical devices.

**GENERAL COMMENTS:**

**CHECK POINTS:**

C-1 Check Job Sheet REW-11a.

C-2 Check Job Sheet REW-11b. Assign the student five different items in the lab to measure.

C-3 Check Job Sheet REW-11c.

UNIT NO. REW-12

OBJECTIVE:

The student will be able to identify and draw most electrical symbols used in residential wiring.

GENERAL COMMENTS:

CHECK POINTS:

C-1 Check the student's drawing for proper symbols in the drawing on Job Sheet REW-12a.

C-2 Check student's answers.

C-3 Check student's design.

C-4 Check student's design.

UNIT NO. REW-13

OBJECTIVE:

Estimate wiring materials from a blueprint reading.

GENERAL COMMENTS:

CHECK POINTS:

C-1 Check the student's drawing and price list for estimated materials.

# MAJOR BLOCK

# MAJOR APPLIANCES

MA-01 -- MA-31 Secondary

UNIT NO. MA-01

OBJECTIVE:

Run power for and install electric ranges

GENERAL COMMENTS:

A flush mount and surface mount receptacle is needed along with a free standing range and range cord.

CHECK POINTS:

C-1 Problem #1

A. 8 TW
10 TW

B. 3

C. 40

Problem #2

A. 8 TW
10 TW

B. 3

C. 40

C-2 Check wiring diagram

C-3 Check students wiring project on above diagram

C-4 Check range cord for proper connections. Make sure frame grounging strap is connected to neutral of range cord and range so frame will be grounded.

UNIT NO. MA-02

**OBJECTIVE:**

Install wall oven according to the minimum requirements of the National Electric Code.

**GENERAL COMMENTS:**

Wall mounted oven and necessary wiring and supplies will be needed.

**CHECK POINTS:**

C-1 (1) Check student wiring project for correct size and components.
(2) Check installation wiring of oven.

C-2 Check electrical connections and installation into cabinet. Caution against marring cabinet surface.

C-3 Expect the student to explain all operations of the oven to you as a customer.

**UNIT NO.** MA-03

**OBJECTIVE:**

Install and wire a surface range unit and exhaust hood.

**GENERAL COMMENTS:**

**CHECK POINTS:**

C-1 Make sure the student can properly install the wire and compute for wire size and branch circuit.

C-2 Make sure the student can properly install and check out a cook top.

C-3 Make sure the student can calculate for the circuit and install the conductors properly.

C-4 Make sure the student can properly install a vent hood.

**UNIT NO.** MA-04

**OBJECTIVE:** Install an automatic clothes dryer

**GENERAL COMMENTS:**

**CHECK POINTS:**

C-1 Observe the student's procedure for installing a dryer, including electrical connections and dryer set-up.

C-2 Make sure the student can properly lay out and cut a hole for a dryer vent, then connect the vent to the dryer.

UNIT NO. MA-05

OBJECTIVE:

Install an automatic washing machine.

GENERAL COMMENTS:

CHECK POINTS:

C-1 Make sure the student can properly install the washer and explain the operation of the machine.

**UNIT NO.** MA-06

**OBJECTIVE:**

Install an undercounter automatic dishwasher.

**GENERAL COMMENTS:**

**CHECK POINTS:**

C-1 Check the student's procedure for installing the dishwasher. Check for water leaks, make sure the unit is properly secured, and check the wiring.

**UNIT NO.** MA-07

**OBJECTIVE:** Install and operate a garbage disposal unit

**GENERAL COMMENTS:**

**CHECK POINTS:**

C-1 Inspect students installation for proper working condition and for leaks.

C-2 Orally test the students knowledge of the operation of the disposal installed in Job Sheet.

**UNIT NO.** MA-08

**OBJECTIVE:**

Uncrate, service, and install a refrigerator freezer.

**GENERAL COMMENTS:**

**CHECK POINTS:**

C-1 Make sure the student can properly install an ice maker.

C-2 Make sure the student can properly install a refrigerator.

C-3 Make sure the student thoroughly understands the operation of the appliance.

UNIT NO. MA-09

OBJECTIVE:

Use the hand truck to move heavy appliances.

GENERAL COMMENTS:

A hand truck with belt and stair rollers is needed.

CHECK POINTS:

C-1 Make sure the student knows how to:

1. Check the trucks.
2. Place an appliance on the trucks.
3. Move the appliance up and down steps.

UNIT NO. MA-10

OBJECTIVE:

Identify, remove, and replace all components in a washing machine.

GENERAL COMMENTS:

Have plenty of spare parts that have been tagged and numbered. The parts should be the same ones talked about in the information sheet and audio visual.

CHECK POINTS:

C-1 1-B, 2-G, 3-E, 4-F, 5-C, 6-I, 7-A, 8-H, 9-D, 10-J.

C-2 Check to see if student can identify and explain the function of the various parts.

C-3 Check to see if parts are properly labeled and identified and look for any damage caused during disassembly. Give any needed assembly instructions at this time.

Check for correct procedures, any damage, and the craftsmanship of the project.

UNIT NO. MA-11

OBJECTIVE:

Identify the components and troubleshoot washing machine electrical system.

GENERAL COMMENTS:

CHECK POINTS:

C-1 1. 9, 13, 34, 46

2. 7

3. low motor

4. 1

5. 13

C-2 1. To move the cam a few degrees of rotation at a time and to give the witches snap action.

2. (1) motor, (2) multiple circuit cam switches, (3) escapement

3. Water pressure - air pressure

4. When current flows through a conductor there is a magnetic field built up around the coil when a moveable core is placed inside the coil the moveable core will be drawn inside because the magnetic lines of force tend to become as short as possible.

5. Split phase - capacitor start induction run.

C-3 Make sure the student can correctly remove and identify the electrical parts.

C-4 Make sure the student has properly replaced the parts and has put the wires on the correct location.

C-5 Make sure the student has correctly make the needed repairs to the machine or machines assigned to him.

UNIT NO. MA-12

**OBJECTIVE:**

Check and install capacitors on automatic washing machines.

**GENERAL COMMENTS:**

Students will need an assortment of used capacitors to check the ratings. At least five appliances will be needed to check and test capacitors. At least one should be available for replacement.

**CHECK POINTS:**

C-1 Check the student responses to Assignment Sheet MA-12a.

1. A. Common Wiring
   B. Starting Circuit
   C. Capacitor
   D. Start-Winding
   E. Run-Winding
   F. Overload Relay

2. A. Motor hums but will not start.
   B. Motor runs but will not reach full speed.

3. A. Problems in common wiring
   B. Opens or shorts in windings
   C. Open overload relay
   D. Open times switch

C-2 Student should have determined the ratings of at least five capacitors. Each capacitor should be labeled with a number and the appropriate rating.

C-3 A. Students should have completed thier diagnosis of at least five capacitors which are housed inside washing machines and recommended corrective action.

B. Student should diagnose at least one malfunctioning capacitor and install it in the appropriate appliance.

UNIT NO. MA-13

**OBJECTIVE:**

Identify and install the components of the mechanical system on an automatic washing machine.

**GENERAL COMMENTS:**

A washing machine which is not functional will prove useful for disassembly of the mechanical system.

A functional machine or one in need of repair of the mechanical system should be made available for the student to diagnose and repair.

**CHECK POINTS:**

C-1 Check the student's answers to Assignment Sheet MA-12a: 1) a. agitate, b. spin, c. damper or snubber; 2) connecting rod; 3) yes; 4) when the spin cam bar is moved forward the clutch pin is raised separating the clutch and activating the brake.

C-2 A. Make sure the students can identify the mechanical parts on a washing machine.

B. Before the student has completely reassembled the machine, check to see that the parts have been replaced properly, then check again when reassembly is complete.

C-3 Make sure the student can correctly identify and suggest possible corrective measures for two or three mechanical system problems.

T NO. MA-14

OBJECTIVE:

Check, identify belt types, and adjust tension on belts.

GENERAL COMMENTS:

At least one operational machine will be needed on which the belt tension can be adjusted and replaced. It also may be desirable to keep an assortment of worn and burned belts to allow students to determine belt condition.

CHECK POINTS:

C-1 Check to see if student can:

1. Identify belt types
2. Identify belt problems
3. Tell how to adjust tension
    a. new belts
    b. old belts

C-2 Check to see if student can properly adjust belt tension.

C-3 Observe to see if student can correctly replace a washer belt.

UNIT NO. MA-15

OBJECTIVE:

Diagnose and service/repair washing machine water system.

GENERAL COMMENTS:

At least one or two operational washing machines will be needed for this unit. Assembly and disassembly can be performed on a dysfunctional machine. Procedures for Job Sheet MA-15b are related to Kenmore washers.

CHECK POINTS:

C-1 Make sure the student understands the operation of the water system as far as the direction of water flow is concerned for the different steps.

C-2 Make sure the student understands the operation of the valve and can identify the parts of the valve.

C-3 Check to make sure student can identify the water system parts. Give the student any needed instructions for reassembly. Check to see that the machine has been correct reassembled.

C-4 Make sure the student has correctly identified the problems and has taken the proper course of action to repair the problem.

UNIT NO. MA-16

OBJECTIVE:

Identify components and troubleshoot the mechanical system of an automatic clothes dryer.

GENERAL COMMENTS:

An automatic dryer which is not operational can be used for disassembly, however, an operational dryer will be needed for the troubleshooting activities.

CHECK POINTS:

C-1 Make sure the student has properly identified the mechanical and air system parts. Observe the student as the dryer components are reassembled.

C-2 (A) Students should identify the problems which exist in the mechanical system of an automatic dryer and make the needed repair.

(B) Observe the student to insure that trouble shooting procedures have been followed.

UNIT NO. MA-17

**OBJECTIVE:**

Diagnose and repair electrical problems in an automatic clothes dryer.

**GENERAL COMMENTS:**

A dryer will be needed on which the disassembly of electrical components can be performed. This may be either an operational machine or one which is sysfunctional. An operational dryer will be needed on which troubleshooting procedures may be performed.

**CHECK POINTS:**

C-1 (A) Make sure the student has correctly identified the electrical parts.

(B) Make sure the student can also correctly reassemble the dryer.

C-2 (A) Make sure the student can identify electrical problems in a dryer.

(B) Make sure the student can make repairs on a dryer. Observe as the student operates the dryer to insure repairs are done correctly.

UNIT NO. MA-18

OBJECTIVE:

Test and replace the solenoid on an automatic dishwasher.

GENERAL COMMENTS:

CHECK POINTS:

C-1 Check the students' responses to Assignment Sheet MA-18a

C-2 Observe the student as the testing is done on the machine. When the covering has been replaced observe as the student operates the machine.

**UNIT NO.** MA-19

**OBJECTIVE:**

Check the water level control and replace the door switch on an automatic dishwasher.

**GENERAL COMMENTS:**

**CHECK POINTS:**

C-1 Check the student's work to insure correct procedures are being followed in the removal of door panels. Also, check the students continuity reading.

C-2 Check answers on Assignment Sheet MA-19a.

C-3 Check the student's work to insure correct procedures are being followed in the removal of parts and in checking continuity.

UNIT NO. MA-20

OBJECTIVE:

Test and replace heating elements on an automatic dishwasher.

GENERAL COMMENTS:

CHECK POINTS:

C-1 Student will give an oral answer to the questions in Assignment Sheet a.

C-2 Check student ability to check, remove, and re-install a heating element.

**UNIT NO.** MA-21

**OBJECTIVE:** Check and Replace Motor Relays

**GENERAL COMMENTS:**

**CHECK POINTS:**

C-1 Check answers on Assignment Sheet MA-21a

C-2 Inspect the students procedure for removing panels, checking the relay coil and checking the contacts in the relay.

UNIT NO. MA-22

OBJECTIVE: Replace and check automatic dispenser on dishwasher

GENERAL COMMENTS:

CHECK POINTS:

C-1 Check student's answers on Assignment Sheet A.

C-2 Orally question student concerning the removal and replacement of the detergent dispenser and the wetting agent dispenser. Also check the student's work.

UNIT NO. MA-23

OBJECTIVE:

Check and replace drain pumps on automatic dishwashers.

GENERAL COMMENTS:

CHECK POINTS:

C-1 Check the student's explanation of the operation of the drain systems illustrated.

C-2 Periodically check the progress of the removal and servicing of the dishwasher drain pump.

UNIT NO. MA-24

OBJECTIVE: Test and replace timer on automatic dishwasher.

GENERAL COMMENTS:

CHECK POINTS:

C-1 Check the answers on Assignment Sheet a

C-2 Inspect the student's work for proper procedure in testing the motor and contacts, and removing and replacing the timer.

UNIT NO. MA-25

OBJECTIVE:

Diagnose and repair an automatic dishwasher.

GENERAL COMMENTS:

For the job assignment in this package the instructor must "bug" an automatic dishwasher. This should be a culminating experience for the student, testing the knowledge and skills obtained in previous units.

CHECK POINTS:

C-1 Check the students diagnosis and repair procedure.

C-2 Determine if student has made a quick efficient diagnosis and has completed the repairs needed.

UNIT NO. MA-26

OBJECTIVE:

Test and replace surface unit elements.

GENERAL COMMENTS:

Several types of elements should be on hand for testing. These elements should have known defects. At least one operational range should be available.

CHECK POINTS:

C-1 Observe students use of VOM and check results on Job Sheet.

C-2 Check results on Job Sheet.

**UNIT NO.** MA-27

**OBJECTIVE:** Test and replace service unit switches

**GENERAL COMMENTS:**

**CHECK POINTS:**

C-1 Check the student's procedure for testing surface switches cold.

C-2 Check the student's procedure for testing infinite switches with a load.

C-3 Check the student's ability to properly test and replace infinite switches.

C-4 Check the students ability to properly test and replace step switches.

UNIT NO. MA-28

OBJECTIVE: Test and replace bake and broil heating elements on an electric oven.

GENERAL COMMENTS:

CHECK POINTS:

C-1 Check the student's ability to correctly test an oven heating element. Determine if student can identify an element according to type of terminal.

C-2 Check the student's ability to check, remove, and replace the bake and broil element in an oven.

**UNIT NO.** MA-29

**OBJECTIVE:** Test and Replace Oven Temperature Controls

**GENERAL COMMENTS:**

**CHECK POINTS:**

C-1 Check the student's ability to correctly remove the oven thermostat.

C-2 Check the student's ability to properly calibrate an oven thermostat.

**UNIT NO.** MA-30

**OBJECTIVE:** Remove and replace an automatic timer on an electric range

**GENERAL COMMENTS:**

**CHECK POINTS:**

C-1 Check the student's procedure for removing, testing, and replacing the automatic timer on an electric range.

**UNIT NO.** MA-31

**OBJECTIVE:**

Service a continuous cleaning and a self cleaning oven.

**GENERAL COMMENTS:**

**CHECK POINTS:**

C-1 Check the students' answers to Assignment Sheet MA-31a.

C-2 Check the students' repair of the porcelain interior of a continuous cleaning oven.

C-3 Check the student's answers on Assignment Sheet MA-31b.

C-4 Check the student's progress, as the components of the self cleaning oven are serviced.

# MAJOR BLOCK

## HEATING

HE-01 -- HE-29 Post Secondary

UNIT NO. HE-01

OBJECTIVE:

Demonstrate a knowledge of the principles involved in the operation of electric furnaces and controls.

GENERAL COMMENTS:

Students must explain the operation sequence of a heating unit and schematic. Students may need to review the reading assignment and the slide presentation for the second time before being able to complete this unit. Also they will need an operational heating unit to identify and wire the components.

CHECK POINTS:

C-1 1. Operational sequence for Assignment Sheet HE-01a.
  A. Power supplied to 240 volt side transformer.
  B. 24 volt supplied to thermostat.
  C. Thermostat closes, energizing coil of sequencer #1.
  D. Thirty to sixty seconds sequencer one main auxiliary contacts close.
  E. Current passes through fuses, thermal L.L. and fusible links to heat strip #1.
  F. Strip #1 heats up.
  G. Auxiliary contacts of sequencer #1 energize sequencer #2.
  H. Thirty to sixty seconds sequencer #2 contacts close.
  I. Circuit is completed to heater #2 and to sequencer coil #3.
  J. Thirty to sixty seconds sequencer #3 contacts close.
  K. Heater #3 is energized.
  L. Fan switch heats up and closes.
  M. Fan motor low speed energizes through fan relay N.C. and fan switch.

2. A. 30 amp fuses
  B. Limit controls (thermal O.L.)
  C. Fusible links

3. Resisitive heat and coils, they heat up a bimetal that opens and closes the points.

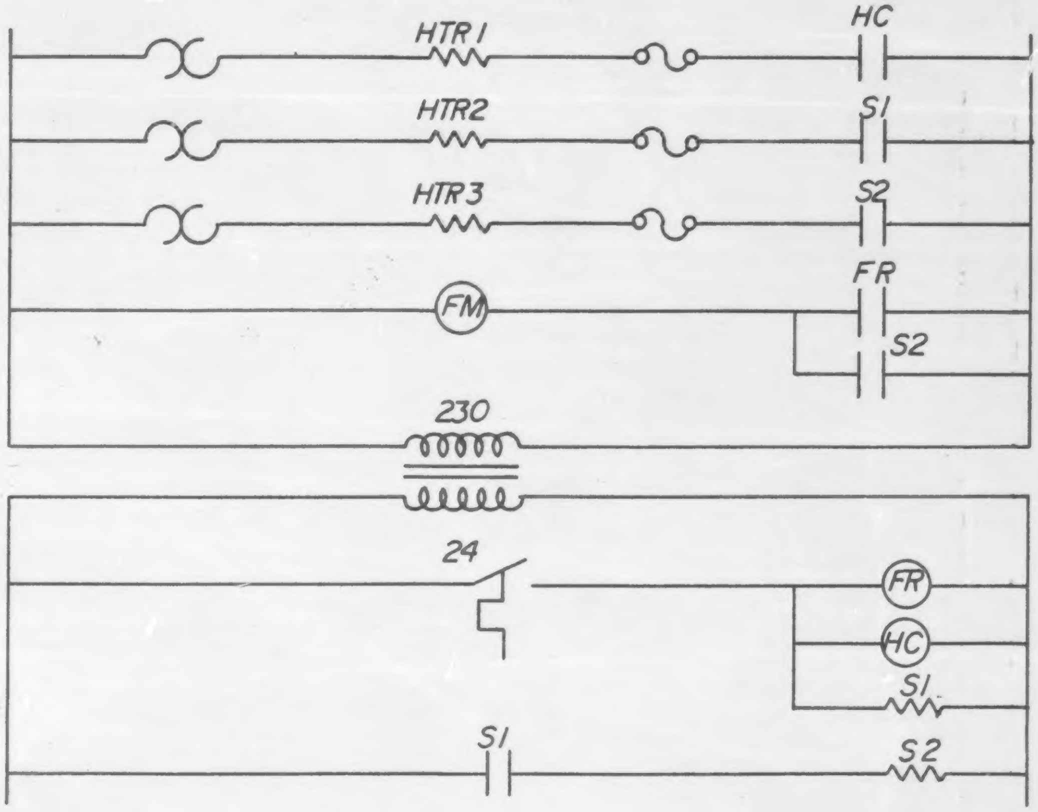
4. Fan switch is thermally activated.

C-2 The students should be able to operate the furnace. They should be able to locate and set the thermostat and any power disconnects. Listed below are typical values for the items in the checklist:
Fan current - 2 amps
Fan voltage - 230 volts
Element current - 20 amps apiece
Element current - 60 amps (15 KW furnace)
Element voltage - 230 volts

1. Fan switch and or sequencer
2. When the temperature rises with a fan switch; when the first sequencer energizes with sequencer.
3. On temperature drop if controlled solely by a fan switch; when the last sequencer shuts off if sequencer controlled.
4. Simply count the heat strips.
5. Approximately 5 KW for most furnaces.
6. Student should specify what energizes each strip and the sequence of operation. Be sure that he/she includes time lay.

Unit should operate as listed in the specification sheet. The fan should remain on until the last strip has de-energized.

C-3



C-4 Students should have wired the circuit which was designed in Assignment Sheet HE-016 on equipment assigned by the instructor. Check the student's work and evaluate the work for this unit.

UNIT NO. HE-02

OBJECTIVE:

Install an electric furnace using manufacturer's installation instructions and wiring charts.

GENERAL COMMENTS:

An electric furnace complete with manufacturer's installation instructions, wiring and thermostat is needed.

CHECK POINTS:

C-1 Check Assignment Sheet HE-02a

(A) Most electric furnaces may be positioned in any way except one which would have the fan cage hanging on the blower bearings.

(B) Most electric furnaces require from 0" to 3" clearance on all sides.

(C) A straight heat thermostat with an electric heat subbase is used.

(D) Most furnaces may not be wired with aluminum wire. Some manufacturers will void warranty.

Wire sizing charts are usually provided. However, if not, simply refer to the N.E.C.

C-2 Check installation clearances, thermostat location, and wiring for correct size and type.

UNIT NO. HE-03

OBJECTIVE:

Use an operational sequence and troubleshoot electric furances.

GENERAL COMMENTS:

Below is a list of suggested problems to give the student. Assign at least five problems to the student to fix. They do not have to be on the same furnace. Transformer - primary winding or secondary winding. Thermostat-bad heat anticipator. Sequencers - bad coil, bad points. Relay - coil or points. Elements - open, shorted, or grounded. Fusible links - open. Overloads - open. Motor - windings, capacitor bearings.

CHECK POINTS:

C-1 Check Assignment Sheet HE-03a. Students should have studied the wiring diagrams of three units and made an operational sequence for troubleshooting for each unit.

C-2 Be sure that the student understands how the unit works. Not approximately but exactly! The operational sequence that students write should make it clear if they fully understand the unit's operation.

UNIT NO. HE-04

OBJECTIVE:

To develop a safety consciousness in installing and working with gas fired heating systems.

GENERAL COMMENTS:

CHECK POINTS:

C-1 Answer key to Assignment Sheet HE-04a

1. natural gas, liquid petroleum gas, mixed gas, manufactured gas
2. liquid petroleum gas
3. Natural 0.5-0.65
   Propane 1.52
4. 32°F, 0°C
5. natural 100-1075, propane 2500-2550, mixed 600-800, manufactured 500-600
6.

| | MIXED | MANUFACTURED |
|---|---|---|
| ORIGIN | mixture of several gases | created through coke production |
| HEAT CONTENT | 600-800 | 500-600 |
| SPECIFIC GRAVITY | 0.6 | 0.6 |
| USAGE | limited | almost none |

C-2 Student should fill in chart on job sheet. Possible gases are: natural, propane, butane, acetylene

| Natural | Propane | Butane |
|---|---|---|
| gas furnace | halid detector | lighter |
| 0.6 | 1.52 | 2.0 |
| 1000 BTU/$ft^3$ | 2500 BTU/$ft^3$ | 3200 |
| gas | liquid | liquid |

C-3 Answer key to Assignment Sheet HE-04b

1. B
2. C
3. A
4. B
5. A
6. D

C-4 Student should compose a list with inspections that are reasonable and possible in your lab. Some possible items are:

A. gas leaks
B. improper clearance
C. improper venting
D. combustible products nearby
E. improper wiring
F. improper combustion air

C-5 Student should find at least 3 gas-related safety hazards in your shop. He should also recommend possible solutions for each problem. If necessary, the instructor should discretely "bug" a few units for the student to find.

UNIT NO. HE-05

OBJECTIVE:

Identify components and functions of four basic gas heating systems.

GENERAL COMMENTS:

Job Sheet HE-05a: An older model gas burning heating system similar to the one described in this package will be needed. It is suggested that the student use string tags to label equipment parts. Have the student put his/her name and heater unit serial number on one side of tag and the name and function of each component on the other side. Nine tags will be needed for each student.

Job Sheet HE-05b: It is important to have serial numbers on all four furnaces used.

CHECK POINTS:

C-1 1. Storage tank, high pressure, liquid gas
2. Pressure regulator, high pressure-low pressure
3. BASSO Valve
4. Gas solenoid valve
5. Pilot assembly
6. Thermocouple
7. Burner
8. Heat exchanger
9. Draft diverter vent pipe

C-2 Check labels students have put on the components and see if they have described name and function correctly.

C-3 Check Assignment Sheet HE-05b

C-4 Determine if student can identify types of furnaces.

UNIT NO. HE-06

OBJECTIVE:

Check gas sources and determine the rate of consumption.

GENERAL COMMENTS:

Students will need access to an operating gas meter. The meter available at the school or training facility may be useful for this purpose.

CHECK POINTS:

C-1 (1) T; (2) T; (3) T; (4) F, Welted surface is the total surface area of the tank exposed to the liquid in the tank. (5) F, double regulation refers to the use of two regualtors, not a double regulator. (6) T.

C-2 (1) 2.5" W.C. (6) (7) (8)
(2) 5" W.C.
(3) 3" W.C.
(4) 6" W.C.
(5) 3.5" W.C. (9) (10)

C-3 (1) 558,000 cubic feet
(2) 327,000 cubic feet
(3) 194,000 cubic feet
(4) 239,000 cubic feet
(5) 643,000 cubic feet

C-4 Students should count the number of dial turns in a measured time interval (two minutes). They should be able to relate to the instructor the cubic foot per hour being consumed.

C-5 If possible, assign the student one natural gas unit and one L.P. unit. The readings at the source should be taken off of the gas line before entering the unit. The drip tee makes a convenient place to take the reading. The readings at the unit should be taken off of the manifold or the gas valve. Discuss any pressure drop discovered at the source when the unit is turned on. The reading at the unit with the unit off should be 0 in all cases.

UNIT NO. HE-07

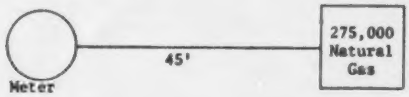
OBJECTIVE:

Calculate and install piping for gas heating systems.

GENERAL COMMENTS:

CHECK POINTS:

C-1

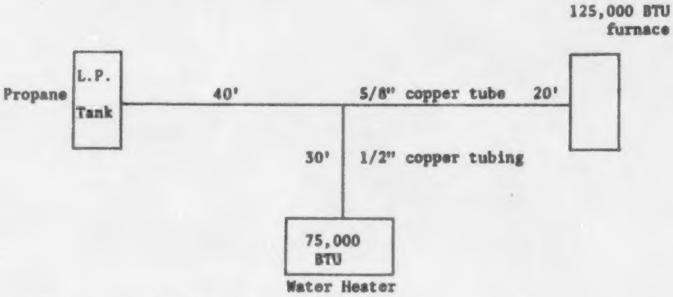

Meter
45'
275,000
Natural
Gas

$\frac{275,000}{1000}$ with S.G. of 0.6

(heat control)

| | |
|---|---|
| runout | 45 |
| consumption | 275 ft$^3$/Hr. |
| pressure drop | 0.5" W.G. |
| diversity factor 1 | |

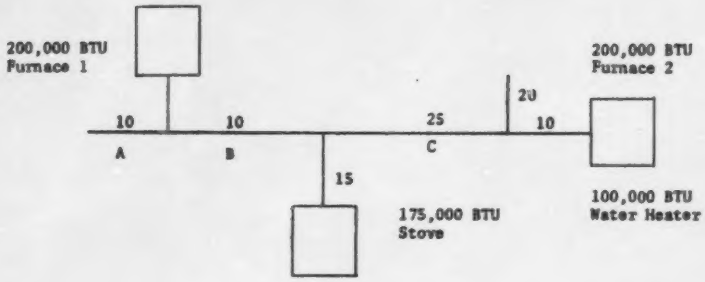
ANSWER: 1" iron pipe from chart


125,000 BTU
furnace
Propane
L.P.
Tank
40'
5/8" copper tube
20'
30'
1/2" copper tubing
75,000
BTU
Water Heater

| | |
|---|---|
| S. G. | 1.5 |
| runout | 70' |
| consumption | $\frac{200,000}{2500}$ = 80 cu. feet total |
| | $\frac{125,000}{2500}$ = 50 cu. feet furnace |
| | $\frac{75,000}{2500}$ = 30 cu. feet water heater |

pressure drop 0.5" W.G.
diversity factor = 1, chart HE-4b
3/4" copper tubing to branch
5/8" copper tubing to furnace from branch
1/2" copper tubing to water heater from branch

C-1
(Continued)



| | | Natural | L.P. |
|---|---|---|---|
| S.G. | | 0.6 | 1.5 |
| Runout | | 65' | 65' |
| Consumption | Section A | $\frac{675,000}{1000} = 675 \text{ ft}^3$ | $\frac{675,000}{2500} = 270 \text{ ft.}^3$ |
| | Section B | $\frac{475,000}{1000} = 475 \text{ ft.}^3$ | $\frac{475,000}{2500} = 190 \text{ ft.}^3$ |
| | Section C | $\frac{300,000}{1000} = 300 \text{ ft.}^3$ | $\frac{300,000}{2500} = 120 \text{ ft.}^3$ |
| Furnace #1, #2 | | $\frac{200,000}{1000} = 200 \text{ ft.}^3$ | $\frac{200,000}{2500} = 80 \text{ ft.}^3$ |
| Water Heater | | $\frac{100,000}{1000} = 100 \text{ ft.}^3$ | $\frac{100,000}{2500} = 40 \text{ ft.}^3$ |
| Stove | | $\frac{175,000}{1000} = 175 \text{ ft.}^3$ | $\frac{175,000}{2500} = 70 \text{ ft.}^3$ |

Diversity Factor = 1
Chart Natural
Propane, Factor .63 from HE-4L
Natural - iron pipe
Propane - iron pipe

| | Natural | Factors for L.P. | Propane |
|---|---|---|---|
| A | 1¼" | 490 x .63 = 308.7 | 1¼" |
| B | 1¼" | 490 x .63 = 308.7 | 1¼" |
| C | 1¼" | 240 x .63 = 151.2 | 1" |
| Furnace #1 | 1" | 240 x .63 = 151.2 | 1" |
| Furnace #2 | 1" | 240 x .63 = 151.2 | 1" |
| Water Heater | 3/4" | 125 x .63 = 78.75 | 3/4" |
| Stove | 1" | 125 x .63 = 78.75 | 3/4" |

C-2 Check Job Sheet HE-07a.

C-3 Check to be sure the student:

a. used the correct material.
b. joined the material properly.
c. installed 1/4" pitch for every 15' of run.
d. installed a drop leg.
e. installed a cutoff at the unit.
f. installed a union at the unit.
g. supported the pipe properly.

UNIT NO. HE-08

OBJECTIVE:

Install and adjust gas pressure regulator(s)

GENERAL COMMENTS:

Students will need a regulator which can be disassembled and reassembled. Also, equipment should be available so that adjustment and installation of different types of gas regulators will be required.

CHECK POINTS:

C-1 After disassembly, the student should show the instructor the regulator to make sure that it is fully disassembled. Inspect the reassembled regulator to see if it has been assembled correctly. The student's data sheet should correspond to the regulator assigned.

C-2 Check Assignment Sheet HE-08a

(A) System #1 could be operated off of one regulator. Regulators C, E, would handle the load by themselves. Either one should be adjusted to 3½" W.C. If double regulators were used, regulators C or E could be used as a primary regulator. They should then be adjusted to 7" W.C. Regulators C, E, H, could be used as a secondary regulator for the furnace. Any of them should be adjusted to 3½" W.C. when used as a secondary regulator. Regulators C, E, B, H, could be used as a secondary regulator for the water heater. They should also be adjusted to 3½" W.C.

(B) System #2 cannot be operated off of one regulator. Regulator G will work as a primary regulator. It should regulate down to approximately 15" W.C. Regulator G will also work as the secondary regulator on the boiler. It should be set at 11" W.C. Regulators A, D, F, G could all be used as the secondary regulator on the stove. They should be set at 11" W.C. Regulators A, D, G, will all work as the secondary regulator for the water heater. They should be set at 11" W.C.

Assign two units for the student to install regulators. Utilize different types if available. Make sure to assign the student a regulator which needs adjusting. The student should explain the pressure capacity as needed for the unit. Check the data sheet. It should help the student determine the type and size regulator needed.

UNIT NO. HE-09

OBJECTIVE:

Recognize and install gas valves

GENERAL COMMENTS:

An assortment of valves should be kept on hand. Students will be required to disassemble and reassemble one of each type. Assembly can be done on inoperative valves. An operational valve will be needed, however, for installation on the furnace unit.

CHECK POINTS:

C-1 Check the answers on Assignment Sheet HE-09a:

1. a, b, c
2. and
3. d
4. b
5. d
6. b
7. d
8. a, c, d
9. b, c
10. b

C-2 Require that students identify each valve and explain the flow of gas. Check the student after disassembly has been performed on each valve.

C-3 Check the gas valve for proper installation. Check for leaks and have the student operate the furnace and check its operation.

UNIT NO. HE-10

OBJECTIVE:

Diagnose problems in pilot ignition devices.

GENERAL COMMENTS:

CHECK POINTS:

C-1 At this point the student should have a basic understanding of pilot burners and pilot burner problems. He should also be familiar with the common ignition devices. Answer any questions he might have or ask him some, to be sure he has this basic knowledge.

C-2 The student is going to make an open and closed circuit test of a thermocouple. Discuss safety with him and make sure he can use the millivolt tester.

C-3 Answer any questions the student might have concerning the test or about thermocouple and millivoltage solenoid coil.

C-4 Check the students job sheet, make sure he can identify these different type systems.

C-5 Assign the student to the proper furnace to be used in next Job Sheet, Ask safety questions.

C-6 Answer any questions the student might have concerning pilot or thermocouple operation.

C-7 Assign student to the furnace he will use in job sheet also be prepared to (bug) the unit for troubleshooting after the student has become familiar with the systems.

C-8 Make sure the system still works properly after all (bugs) have been located. Discuss system with student.

UNIT NO. HE-11

OBJECTIVE:

Troubleshoot and replace combination gas valves

GENERAL COMMENTS:

CHECK POINTS:

C-1 Assignment Sheet Answers

1. Manual on-off, pilot supply and safety cut off, gas pressure regulator, main operator coil, solenoid or heater.
2. No
3. With the manual knob in the pilot position and depressed safety is bypassed and gas can flow to the pilot.
4. When 24 volts is applied to the main operator, solenoid, or heater the valve is opened.
5. The thermocouple provides the millivolts necessary to energize the solenoid coil that controls the flow of all gas into the valve.
6. Yes, remove cover and turn adjustment screw up or down as needed.
7. No
8. Remove cover, to expose adjustment screw. Put a manometer on manifold, with the main burner lit, adjust to 3 1/2 inches water column.
9. The millivoltage solenoid.
10. No

C-2 Check the data sheet answers, make sure the student completely dismantled the valve and understands the valve operation.

C-3 Check the job just completed by the student. Make sure the student followed the installation instructions on the job sheet. Check furnace operation. Answer any questions the student might have concerning the installation.

UNIT NO. HE-12

OBJECTIVE:

Remove and service burners on gas furnaces.

GENERAL COMMENTS:

CHECK POINTS:

C-1 Assignment Sheet Answers:

(1) To mix the primary air and gas, and deliver the mixture to the combustion area. (2) A spud. (3) As gas, under pressure enters the burner, a negative pressure is created behind it which draws the primary air into the burner venturi. (4) A yellow flame and incomplete combustion. (5) The flame lifts off the burner, is noisy and could blow itself out and produce carbon monoxide. (6) Drilled port - slotted port - ribbon - inshot. (7) Adjustable shutter - threaded shutter - non-adjustable shutter - deflector shutter. (8) On boilers and other commercial equipment. (9) Upflow-downflow - horizontal. (10) Packaged, rooftop or combination gas - electric units.

C-2 Close the primary air shutters or misadjust the shutters on two gas furnaces. Assign the student to correct this.

C-3 Check each furnace, make sure the flame is properly adjusted on both furnaces. Assign one of the furnaces to the student for his/her next job-cleaning the burners.

C-4 Check the flame adjustment and burner alignment after student has completed the job. Does he/she recognize the burner type? Drilled port, slotted port, ribbon, inshot. Any other questions you might have.

**UNIT NO.** HE-13a

**OBJECTIVE:** Determine and correct temperature rise of heat exchangers

**GENERAL COMMENTS:** An operating ducted furnace is needed.

**CHECK POINTS:**

C-1 Check student response to questions.

C-2 Check student's ability to:
    (a) Determine temperature rise
    (b) Correct temperature rise
    (c) Inspect heat exchangers

UNIT NO. HE-14

OBJECTIVE:

Make calculations for and install a gas heat venting system.

GENERAL COMMENTS:

CHECK POINTS:

C-1 Assignment A

Condition One: 4500 CFM - 100 square inches each grill

Condition Two: 7200 CFM - 40 square inches each grill
80 square inches each duct

C-2 Assignment Sheet B

1. Six inch vent.
2. Water heater vent 4", furnace vent 6", combined vent 7".
3. It is only 4 feet high, it should be a minimumof 5 feet above the draft hood.
4. Three appliances that must be vented are: steam and hot water boilers, warm air furnaces, floor furnaces, wall furnaces, unit heaters, duct heaters, incinerators, water heaters over 5,000 BTU, listed cooking units, room heaters and clothes dryers.

   Three appliances that do not require venting: listed ranges, cooking units listed and marked as unvented, listed type I clothes dryers, listed water heaters under 5,000 BTU, room heaters listed for unvented use, laboratory burners.
5. The smaller appliance, water heater, should be under the common vent.
6. A double wall round gas vent pipe for venting gas appliances with draft hoods and other gas appliances listed for use with type B gas vents.
7. Type B-W is used to vent listed gas fired vented wall furnaces.
8. Only when the fireplace opening is permanently sealed.
9. Because the high temperature differentials may cause condensation of flue gas.
10. They must have a venting capacity not less than that of the gas vent to which it is attached.

C-3 Check sizing and installation of assigned vent systems.

UNIT NO. HE-15

**OBJECTIVE:**

Diagnose and service the electrical controls of a gas furnace.

**GENERAL COMMENTS:**

In general there is not a lot of new information in unit 12. The student will be using his accumulated skills to troubleshoot a typical gas furnace and also a roof top or packaged gas cooling system.

**CHECK POINTS:**

C-1 Check his wiring diagrams, ask questions on fan and limit switches.

C-2 Check his data sheet, is it correct for each unit. Ask questions about the results of B through F on the job sheet. Did he return the fan switch settings to original?

C-3 Did he locate and repair the problems you created on this unit? Can he describe what he did or must do to correct the problem?

UNIT NO. HE-16

OBJECTIVE:

Determine the combustion efficiency in a gas heating system

GENERAL COMMENTS:

CHECK POINTS:

C-1 Assignment Sheet Answers

1. 83 1/4 - 16 3/4
2. 78 1/4 - 21 3/4
3. 77 1/4 - 22 3/4
4. An increase of over ½ percent means the fluid needs changing.

C-2 Check the results of the test. Answer any questions the student may have. Ask any questions you feel are important to insure that the student understands the test.

UNIT NO. HE-17

**OBJECTIVE:** Perform a pre-season check on a gas heating system.

**GENERAL COMMENTS:** A working gas fired furnace is needed. A careful note should be made of its condition so that the students check can be compared to known conditions.

**CHECK POINTS:**

C-1 Check over the list the student has prepared

C-2 Determine if the student has located any known malfunctions while performing the pre-season startup.

UNIT NO. HE-18

OBJECTIVE:

Locate, diagnose, and repair combustion and electrical problems in gas furnaces.

GENERAL COMMENTS:

CHECK POINTS:

C-1 Using the students job sheet as a guide. Simulate as many problems as practical in two gas furnaces. These problems can vary according to the skills of the student involved. His job sheet provides a place for the final check.

UNIT NO. HE- 19

**OBJECTIVE:**

Identify types of oil and their used.

**GENERAL COMMENTS:**

Student should learn different grades of oil from chart.

**CHECK POINTS:**

C-1 Answers to Assignment Sheet HE-19a.

1. Resistance to flow.
2. Remperature at which oil will ignite by a flame or spark.
3. (1) oxygen, (2) fuel, (3) spark or flame.
4. The minimum temperature at which oil will flow.
5. #2

UNIT NO. HE-20

OBJECTIVE:

Installing oil tanks and piping.

GENERAL COMMENTS:

Use school's existing fuel oil system for references and lab work.

CHECK POINTS:

C-1 Check Assignment Sheet HE-20a and determine if all piping and components have been appropriately inserted and labeled. Check answers to questions.

A-1 Three inches (3").
A-2 To provide a reservoir for water formed by condensation in the lower end of tank.
A-3 Singe - stage oil pump.

B-1 Copper tubing can be easily damaged or crimped. It should be completely out of the way.
B-2 Oil from the inside tank is gravity fed to the burner.
B-3 Two-stage oil pump.

UNIT NO. HE-21

OBJECTIVE:

Install a low pressure burner on a domestic oil furnace.

GENERAL COMMENTS:

An operational low pressure burner will be needed for installation. A dysfunctional gun type burner will be needed for disassembly and reassembly.

CHECK POINTS:

C-1 Instructor will evaluate the student's progress by administering a verbal quiz.

C-2 The instructor should have checked wiring connections in the preceding step. As the student operates the unit it would be wise to observe operation.

C-3 Students should have disassembled a low pressure burner and labeled all parts names.

UNIT NO. HE-22

OBJECTIVE:

Installing and servicing transformers and electrodes.

GENERAL COMMENTS:

Have in lab one ignition system and service transformer for oil burning heating system or operative unit. Student will install ignition system and wervice transformer and field check unit. Have several ignition parts tagged on a operating oil furnace with access panels open.

CHECK POINTS:

C-1 Instructor will assign student an oil burning unit and have him identify the basic components of an ignition system. Check tag numbers and part function on assignment sheet.

C-2 Instructor should check student's work and observe while the unit is started.

C-3 Instructor check answers on Assignments Sheet HE-22n.

1. (1) Step up high voltage transformer.
   (2) Pair of ignition wires or bus bars.
   (3) An electrode assembly.

2. An apparatus capable of changing an electrical current from a low to a high potential without changing the current energy.

3. Hi-tension.

4. 3/4"

5. (A) Pair of porcelains.
   (B) Electrode rods.
   (C) Set of transporting "high voltage" wires.
   (D) Various cable supports and protective bushings.

6. High nichol alloy.

UNIT NO. HE-23

OBJECTIVE:

Install, repair, and service an oil fuel pump unit.

GENERAL COMMENTS:

Have in Lab one each two-stage and single-stage oil pump. Disassembly and reassembly can be done on inoperative pumps. Have one pump for installation and operation.

CHECK POINTS:

C-1 Check student's work and have him identify internal parts. Check answers to Assignment Sheet HE-23a.

1. Single-stage has one set of internal gears, whereas, the two-stage has two sets of internal gears.
2. Filter or strainer, gear pump, and pressure regulating valve.
3. Transfer the fuel from the source to the burner and raise pressure of the oil in the lines.
4. Bottom of tank. Because it provides an excellent seal against air entering the line and getting to the pump when fuel is low in the tank.
5. Location of fuel tank
6. 12 feet and 10 inches
7. Flexible

C-2 Check student's work and identify external parts. Have student operate unit. Check answers to Assignment Sheet HE-23b.

1. Test gauges
2. Clockwise and counterclockwise
3. 100
4. To close when pump is off so as to keep the fuel from escaping back to the tank.

UNIT NO. HE-23
Page Two

OBJECTIVE:

GENERAL COMMENTS:

CHECK POINTS:

C-2 (continued)

5. Damaged, defective or dirty cutoff

6. A. Drawing power

   B. Restrictions in fuel line

7. Change to a two-stage double-pipe system.

8. Three:

   1. inlet part
   2. return line
   3. pressurizing chamber

9. One-half pint of oil or until all bubbles disappear.

10. Gauges

UNIT NO. HE-24

OBJECTIVE:

Install and service different types of blowers, nozzles, motors and couplings on oil burning heating systems.

GENERAL COMMENTS:

At least one gun type burner assembly should be kept on hand for disassemble and reassemble. This can be accomplished on an inoperative unit. An operational burner assembly should be available for the student to operate.

CHECK POINTS:

C-1 Require that the students identify each component and explain the basic function of each and their relations to other major components.

C-2 Check nozzle installation for correct procedure and for cleanliness. Ask student questions about old nozzle.

C-3 Check students installation and inspection procedures before allowing him/her to operate unit. Have student operate unit and check for any problems he may have overlooked.

UNIT NO. HE-25

OBJECTIVE:

Recognize the types of heat exchanges, vent pipes and perform the combustion efficiency check.

GENERAL COMMENTS:

Have in shop all test equipment needed for performing a combustion efficiency test.

CHECK POINTS:

C-1 Assign student an oil burning unit to perform the combustion efficiency test. Compare student readings with previous readings.

**UNIT NO.** HE-26

**OBJECTIVE:**

Identify and replace primary and safety controls.

**GENERAL COMMENTS:**

Have in the lab an assortment of safety and primary controls, these can be inoperative. Have available at least one operational oil burning unit for student to wire in the controls and operate.

**CHECK POINTS:**

C-1 Student should have been assigned a unit or several units to identify the various control parts. Control parts should be labeled and the appropriate parts named.

C-2 Assign student an oil burning unit to wire controls into the circuitry. Observe the student as the unit is started after each installation.

UNIT NO. HE-27

OBJECTIVE:

To perform pre-season start up and check.

GENERAL COMMENTS:

Have in lab at least one operational oil burning heating unit. Student will perform pre-season check up and run unit.

CHECK POINTS:

C-1 Check student's work and have him run the unit.

UNIT NO. HE-28

OBJECTIVE:

Troubleshoot and repair the fuel-burning heat system.

GENERAL COMMENTS:

Complete operational fuel-oil burning units must be available. The instructor should create a known malfunction in the unit prior to the student doing the trouble shooting guides.

CHECK POINTS:

C-1 Inspect check list to see if student caught known conditions.

C-2 Inspect check list to see if student caught known conditions.

C-3 Inspect check list to see if student caught known conditions.

C-4 Inspect check list to see if student caught known conditions.

C-5 Inspect check list to see if student caught known conditions.

C-6 Inspect check list to see if student caught known conditions.

C-7 Inspect check list to see if student caught known conditions.

C-8 Inspect check list to see if student caught known conditions.

**UNIT NO.** HE-29

**OBJECTIVE:**

Install and service typical humidifier.

**GENERAL COMMENTS:**

A duct mounted power hymidifier will be needed for this activity. A unit with an operational humidifier will be needed to perform routine service.

**CHECK POINTS:**

C-1 Check student's installation, make sure the humidifier is level, that there are no leaks and the humidistat is properly wired.

C-2 Make sure the student understands the parts to be serviced for proper operation. It is the service technician's job to convince the customer that proper maintenance is important to extended operation of the humidifier.

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